Electrical Testing Checklists for Clean Energy Sites

1 Overview & Purpose

This document outlines recommended steps, training and qualifications, equipment, and documentation practices for conducting electrical testing at clean energy sites. It is intended for use by individuals who perform this testing, including construction project, commissioning, and operation managers.

This checklist is a guide for reference and is not a procedure. Each site has different equipment, ratings, and configurations that would require the use of a site-specific procedure. Solid dielectric, plastic, and rubber-based materials under voltage stress in access of 3kV/mm (volts per thickness) fail due to an erosion process associated with a capacitive discharge phenomena known as partial discharge (PD). For further information on testing, refer to ACP's Wind and Solar Underground AC Collection System Cable Testing resource.[1]

2 Testing Checklists

2.1 Pre-Requisites

#	Task	Complete?
1	Develop the objectives, scope, and methodology of the testing with step-by-step procedures that will be followed during the testing.	
2	Develop a detailed schedule and timeline of the testing activities and safety protocols and precautions that will be observed.	
3	Verify workers to perform the testing are Qualified Electrical Workers (QEW)[2] and are proficient with testing equipment to be utilized.	
4	Identify and highlight the components that will be involved on the applicable one-line or three-line drawings. Review and verify they are correct on the drawing	
5	Conduct a Job Safety Analysis (JSA) and Job Hazard Analysis (JHA) for the test being performed. An Activity Hazard Analysis (AHA) and/or Hazardous Energy Control (HEC) may also be applicable in differing circumstances.	
6	Ensure an Electrical Protection Plan is in place.	
7	Convene a pre-testing meeting with site management, environmental, health and safety (EHS) and affected personnel, and the offtaker or utility to review the testing procedures, defining scope of responsibilities, and timeframe.	

[1] https://cleanpower.org/resources/wind-and-solar-underground-ac-collection-system-cable-testing/
[2] https://cleanpower.org/resources/qualified-electrical-worker-program-for-wind-operations/ , https://cleanpower.org/resources/qualified-electrical-worker-program-for-wind-operations/ , https://cleanpower.org/resources/qew-program-for-bess-2023/

2.2 Pre-Testing Tasks

#	Task	Complete?
1	Verify the equipment that will be tested, including the phone cable circuit to ensure the right circuit is being tested.	
2	Ensure the work area is clear of hazards.	
3	Verify the sign posting and barricades or red rope (energized equipment) boundaries in place.	
4	Verify equipment calibration and operating condition and conduct a performance check.	
5	Install Lock out tag out (LOTO) as required per the isolation procedure.	
6	Confirm the equipment is properly connected to the cable system for a positive means of connection. For high voltage tests, terminations must be properly installed and separable connectors must have proper adapters.	
7	*Note that this occurs for very low frequency (VLF) testing when only one or two phases of a three-phase circuit are being tested.* For cable testing, verify that the cables not being tested are properly grounded. Provide acceptable clearances from grounded and metallic surfaces for cable under test. Verify the right cable is being tested by performing a shield continuity test or verify by another means.	
8	Provide 12 to 18 inches of isolation for air insulated components from any ground plain and remove sharp objects with this range.	
9	Remove all unauthorized personnel from the testing site and keep all testing personnel isolated by 10 feet during the test.	

2.3 Testing Process

If at any time during the test there are unexpected conditions or hazards, immediately stop the test and re-brief prior to recommencing.

#	Task	Complete?
1	Set up equipment in accordance with test plan.	
2	Announce on the radio that testing is starting and establish 3-way communication. Receive confirmation from the other end for an all clear.	
3	Ensure the proper time is set for the testing equipment or test performed.	
4	Perform the test in accordance with the cable and accessory manufacturers' instructions. Follow the guidelines and standards for testing the apparatus and voltage class that is being tested for the appropriate voltage.	
5	Upon completion stop test.	
6	Verify the test equipment has stopped.	
7	Ground and discharge the system.	
8	Announce on the radio that testing has concluded.	

3 Supporting Recommendations

3.1 Training & Qualifications

It is recommended that technicians performing electrical testing have the following:

- Basic electrical training, as described in ACP's or the company's Qualified Electrical Worker (QEW) program[3] or test technician training guidelines. [4]
- Training on the equipment that will be tested and used.
- Certifications (provided by the company performing testing).

3.2 Equipment Needed for Testing

- *Note that it is always advised to reference the testing equipment manuals and personnel should be trained and proficient on the test equipment to be used.* Testing equipment (examples include digital multi-meter, megohmmeter, hi-pot tester, tan delta tester, partial discharge diagnostic equipment, or insulation diagnostic tester)
- Required personal protective equipment (PPE). Examples include electrical rated gloves for the system specifications, arc flash suits, fire-retardant (FR) clothing.
- Discharge stick, also known as a grounding stick or discharge rod, is a safety tool used in electrical testing and maintenance to safely discharge residual electrical energy from capacitors or electrical systems before working on them.
- *Note that this is needed for VLF testing or anytime voltage is being applied and that alligator clips are not acceptable.* Grounds with positive means of connection rated properly for the circuit.
- Locks. Locks and tags should be used following company-specific policies or procedures.

3.3 Documentation & Record Keeping

Proper documentation ensures compliance with industry standards, supports maintenance activities, and provides a reference for future testing and troubleshooting. Here are the key types of documentation and records that should be kept:

- Specific parameters used during the test, such as voltage levels, frequency, duration, and any other relevant settings. (Standards examples include IEEE, NETA, IEC, ands NFPA 70B)
- Detailed data collected during the testing, including partial discharge (pC), location, voltage and current measurements, time-stamped readings, and any observed anomalies.
- Visual representations of the test data, such as voltage decay curves or insulation resistance graphs, to aid in analysis and interpretation.

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[3] ACP Wind (https://cleanpower.org/resources/qualified-electrical-worker-program-for-wind-operations/), Solar (https://cleanpower.org/resources/qew-solar-pv-operations/), and Battery Energy Storage System (https://cleanpower.org/resources/qew-program-for-bess-2023/) QEW Programs

[4] ACP Wind (https://cleanpower.org/resources/guidelines-for-entry-level-wind-technician-training/), Solar (https://cleanpower.org/resources/guidelines-for-entry-level-solar-technician-training/), and Battery Energy Storage (https://cleanpower.org/resources/guidelines-for-entry-level-bess-technician-training/) Technician Training Guidelines

- Visual documentation (i.e., pictures) of the test setup, equipment conditions, and any notable events or observations during the test.
- Report summarizing the test results, analysis, and conclusions.
- Identification of any issues detected, recommendations for corrective actions, and follow-up tests if necessary.
- Comparison of current test results with baseline or previous test results to identify trends or changes over time.