

SED Safety Inspection Items for Energy Storage

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**Thank you to PG&E, SCE, SDG&E, NGK, NEC, CESA,
Amber Kinetics and the SED Generation Inspection Section**

California has begun to add large amounts of utility-scale, grid-connected energy storage to its electrical grid. This stems in significant part from CPUC proceeding R.15-03-011, several Commission decisions, and AB 2514, which require the California utilities to procure 1,325 MW of energy storage by 2020, to be operational by 2024. These storage technologies benefit California in multiple ways.

However, these storage technologies also concentrate large amounts of energy in small spaces and require new kinds of safety inspections distinct from those used for existing energy equipment. As a result, Commission Decision 16-01-032 directs the Commission's Safety and Enforcement Division to develop guidelines for its own inspectors to use when looking at energy storage devices at utility-owned sites.

SED convened a working group consisting of California's major utilities, energy storage developers, codes and standards experts, and industry associations to advise and contribute to the development of a checklist for SED inspectors to use. Below is the inspection checklist developed by this working group. Its items are organized generally in order of what an inspector may find during a walk-through of an energy storage site.

- **Is an overall safety plan in place?**
 - Does the facility have a safety plan documented?
 - Does it address manmade and natural disasters like wildfire, earthquake, flood, chemical spill, toxic gas release, explosion, terrorism, etc.?
 - Does it include outreach to first responders and local authorities? i.e. conduct periodic drill with fire, police, hazmat, etc.
 - Does it include training?
 - Are signage and safety placards compliant with American National Standards Institute, National Fire Protection Association, and other applicable standards?
 - Does the facility have a monthly in-service inspections and maintenance checklist?
 - Storage management system (fire monitors, SO₂ monitors, wind sock, log book, smoke detectors, etc.)
 - Fire plan box (on substation fence)
 - Equipment (generators, transformers, switch gear and control cabinet, battery towers, etc.)
 - Does the facility have maintenance records, such as a preventative maintenance log?
 - Does the facility have an appropriate access protocol?

- **Is the facility inspected regularly by the company or utility per manufacturer's recommendations?**
 - Battery Modules.
 - Inspection of cables and wiring.
 - Torque check of bolted connections (when applicable)
 - Insulation resistance measurement (per industry standards)
 - Heater resistance.
 - Battery residence.
 - Cable run.
 - IR or Ultrasound inspection of terminals
 - Insulation resistance measurement (per industry standards)
 - SO₂ detector if applicable.
 - Control cabinet.

- Inspection of cables and wiring.
 - Total system.
 - Protection relay test.
- **Is the facility inspected regularly by the company or utility, per manufacturer's recommendations? (flywheels only)**
 - At commissioning, are flywheel units properly installed, with civil design per manufacturer specification?
 - Inspection of cables and wiring.
 - Insulation resistance measurement of cables.
 - Run automated control system test. Verifies control connectivity, functionality of internal sensors within each flywheel unit – voltage, current, vibration sensing, and vacuum system state. Test carried out from control center.
- **SED inspectors have examined the following** (all inspections will include both visual and records review)
 - Interconnection equipment
 - Inspect interconnection equipment for visual defects, i.e. insulator bushing intact and clean (shiny, not broken or chipped).
 - Interconnection equipment includes, but not limited to the following:
 - Transformer (check nitrogen tank supply if nitrogen-blanketed, inspect connector / enclosure for hotspot, inspect bushing for defect, review oil samples for dissolved gases, moisture and particulate).
 - Circuit breaker (oil-filled, vacuum, or SF6).
 - Disconnect switch (observe any apparent binding on gear linkages).
 - Lighting arrestor and bus-bar (inspect for visual defect).
 - Test remote operability of interconnection equipment.
 - Storage facility
 - Observe any signs of break-in, intrusion, or vandalism.
 - Inspect facility for appropriate fire protection system, i.e. CO₂ suppression (gas cylinders securely fastened per OSHA), sprinkler, fire alarm, detector, extinguisher (C for electrical fire and D for metal (lithium) fire). Review inspection records per NFPA.
 - Inspect SO₂ detector /ask worker to perform operational test. Check if gas sensor and/or vacuum pump (integral to detector) are in working order (Applicable to NaS storage only).
 - Check for wind sock and ensure it is in good condition (Applicable to NaS storage only).
 - Check ambient temperature and humidity to ensure proper operating condition is maintained. Question: Is facility wired to alarm if operating conditions fall out-of-range?
 - Check facility for onsite spares (for frequently failed components). Does facility have a periodic parts replacement list? Are spare parts replenished as needed?
 - Inspect conditions of facility walking and working surfaces, including stairs and railings.
 - Battery enclosure
 - Observe signs of localized overheating (if enclosure shows different color shades or if metal surface is warped, this is indicative of overheating and problem with the battery module inside). Inspect enclosure for damage or signs of structural defect. Inspect for hotspots with IR gun.
 - Inspect air fan/conditioner and filter. Check if fan is running quietly, not squealing or shaking violently. Inspect filter for cleanliness.
 - Check if enclosure is weather-proof and properly grounded.
 - Inspect all electrical and control panel terminal connections for hotspots, corrosion, looseness, or physical damage.
 - Inspect inverters for hotspots, mechanical, and/or structural defects.

- Inspect certifications of all energy storage equipment/component. Are they certified per latest National Electrical Code, Underwriters Laboratory, and applicable standards?
- Battery module (varies by technology)
 - Observe any unusual smell, leak or spill. Feel any unusual heat flux.
 - Check that modules are generally intact and not damaged.
 - Check that wire connectors are clean (not corroded) and not loose or damaged. Perform a heat scan if needed.
 - Ensure all protective relays are tested and calibrated; check calibration stickers.
 - Ensure all cable is secured and in good conditions (not frayed, melted, cut, bended, or otherwise damaged).
- Hazardous materials policy and management program if applicable
 - Are all records kept and maintained per the requirements of the regulations for the site? For example, training.
 - Has a manifest of hazardous material kept on site been generated?
 - Are SDSs available for all hazardous materials kept on site?
 - Is proper hazardous waste disposal in place if required?
 - Are the hazardous materials handled and stored per the regulations?
 - Do the hazardous materials emergency response plan and the equipment to respond to it meet the policy and management program?

Because energy storage technology will evolve over time, this checklist will also need to evolve over time. This list is intended as a beginning point for SED inspectors, who will learn along with the technologies as they develop. In the future, inspection items may be added for as-to-yet unforeseen technologies. Existing inspection items may be changed in response to lessons learned and emerging best practices acquired by SED inspectors and their advisors.

California may be the first state to initiate an energy storage inspection guideline for its inspectors. As other states focus on these technologies, they can draw from this guideline or possibly join together with California to optimize the ways that these technologies are made safe.