

# Substation Equipment Maintenance Requirements

## SUMMARY

This utility standard outlines the requirements for safely inspecting, assessing, maintaining, repairing, and replacing substation equipment. In addition, it directs personnel to follow the detailed instructions and procedures in the [Substation Maintenance and Construction \(SM&C\) Manual](#) (TD-3322M).

This standard also describes maintenance practices that promote safe and reliable electrical service within PG&E's service territory. These maintenance practices apply to all electrical substation facilities owned and/or maintained by PG&E, including those under the operational control of the California Independent System Operator (CAISO) or subject to regulation by CAISO, the North American Electric Reliability Corporation (NERC), the Western Electricity Coordinating Council (WECC), the California Public Utilities Commission (CPUC) and, where applicable, the regulations of other agencies.

## TARGET AUDIENCE

The target audience consists of the following personnel responsible for safely inspecting, assessing, maintaining, repairing, and replacing substation facilities and equipment:

- Substation maintenance and construction (SM&C)
- SM&C compliance
- Substation asset strategy (SAS) and standards
- Onsite contractors (unless other specific requirements are included in their contract)

All employees and contractors performing the work described in this standard must comply with the requirements in this standard.

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## Substation Equipment Maintenance Requirements

### REQUIREMENTS

#### 1 Maintenance Requirements

##### 1.1 Maintenance Plans

1. Establish preventive maintenance plans to conform with the triggers for various systems and equipment, as provided in the attachments to this standard. Refer to [Utility Procedure TD-3320P-12, "Substation SAP Work Management System \(WMS\) Process,"](#) for details on setting up and tracking work and using the tool. The WMS controls corrective maintenance tasks as well.
2. Substation maintenance requirements use a combined time-based and condition-based maintenance approach. A condition-based maintenance strategy combines and uses all available inspection information, diagnostic testing data, and new technologies in conjunction with maintenance practices, histories, and design data to determine the operating condition of equipment.

##### 1.2 Utility Practices

1. Substation maintenance requirements are based on good utility practices, manufacturer's recommendations, and the experience of PG&E employees. Compliance with this standard and its attachments ensures uniformity in implementing work procedures that support system reliability.

##### 1.3 Compliance

1. For preventive work, determine the out-of-compliance date using the notification required end date in the maintenance plan and the maintenance plan cycle.
  - IF the cycle is 1 year or more,  
THEN the out-of-compliance date is the 1<sup>st</sup> day of the year following the year in which the required end date occurs.
  - IF the cycle is less than 1 year,  
THEN the out-of-compliance date is the 1<sup>st</sup> day of the month following the month in which the required end date occurs.
  - a. [Table 1, "Examples of Out-of-Compliance Dates for Preventive Work,"](#) on Page 3 shows out-of-compliance dates versus required end dates for different maintenance plan cycles. Always complete maintenance activities before the out-of-compliance date, unless the activities meet the criteria described in [Attachment 3, "Deferring Preventive Maintenance."](#)

## Substation Equipment Maintenance Requirements

1.3 (continued)

**Table 1. Examples of Out-of-Compliance Dates for Preventive Work**

Maintenance Plan Cycle	Required End Date	Out-of-Compliance Date
8 Years	07/14/2020	01/01/2021
6 Years	07/14/2020	01/01/2021
5 Years	07/14/2020	01/01/2021
4 Years	07/14/2020	01/01/2021
1 Year (12 Months)	07/14/2020	01/01/2021
6 Months	07/14/2020	08/01/2020
1 Month	07/14/2020	08/01/2020

2. Station battery resistance testing is different from other preventive maintenance work. [NERC Reliability Standard PRC-005-6, "Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance,"](#) allows 6- and 18-calendar month maximum maintenance intervals. See the following tables in PRC-005-6 for more information:

- Table 1-4(a), "Component Type – Protection System Station dc Supply Using Vented Lead-Acid (VLA) Batteries"
  - Table 1-4(b), "Component Type – Protection System Station dc Supply Using Valve-Regulated Lead-Acid (VRLA) Batteries"
  - Table 1-4(c), "Component Type – Protection System Station dc Supply Using Nickel-Cadmium (NiCad) Batteries"
- a. Meet testing requirements by performing the PG&E 6- and 12-month battery-resistance testing maintenance activities specified in [Attachment 6, "Station Direct Current Supply Maintenance Template."](#) The following [Table 2](#) provides out-of-compliance examples for battery resistance testing.

**Table 2. Examples of Out-of-Compliance Dates for Battery Resistance Testing**

Battery Type	PG&E Maintenance Plan Cycle	PRC-005-6 Requirement	Previous Resistance Test	Next Out-of-Compliance Date
VRLA Batteries	6 Months	6 Calendar Months	01/14/2020	08/01/2020
VLA Batteries	12 Months	18 Calendar Months	07/14/2020	02/01/2022
NiCad Batteries	12 Months	18 Calendar Months	07/14/2020	02/01/2022

## Substation Equipment Maintenance Requirements

### 1.3 (continued)

3. For corrective work, the Line Corrective (LC) notification defines the following:
  - a. The notification date: the date when the non-conformance or abnormal working condition was found in the field.
  - b. The required end date: the date automatically determined by the priority level and notification date.

**Table 3. Examples of Required End Date Determination for Corrective Work**

Priority	Notification Date	Required End Date
Priority A (within 30 days)	09/01/2021	10/01/2021
Priority B (within 90 days)	09/01/2021	11/30/2021
Priority E (within 365 days)	09/01/2021	09/01/2022
Priority F (greater than 365 days)	09/01/2021	09/01/2023

- c. The out-of-compliance date for LC notifications is determined by the priority level and required end date.
  - (1) Close **Priority A** notifications (after removing the hazard [make safe] with either permanent or temporary repairs) within 30 days. Create a new lower priority notification immediately for any remaining work that will exceed 30 days. Reference the Priority A notification number to ensure a record of temporary repairs is linked to the new notification.
  - (2) For **Priority B** notifications, the out-of-compliance date is the 1<sup>st</sup> day of the 2<sup>nd</sup> month following the month in which the required end date occurs.
  - (3) For **Priority E** notifications, the out-of-compliance date is the 1<sup>st</sup> day of the year following the year in which the required end date occurs.
  - (4) For **Priority F** notifications, there is no out-of-compliance date. This work will be completed when it is operationally efficient to perform the work.

**Table 4. Examples of Out-of-Compliance Dates for Corrective Work**

Priority	Required End Date	Out-of-Compliance Date
Priority A (within 30 days)	N/A	Must close within 30 days.
Priority B (within 90 days)	07/14/2020	09/01/2020
Priority E (within 365 days)	07/14/2020	01/01/2021
Priority F (greater than 365 days)	07/14/2020	None

- d. Corrective activities may be reassessed, in accordance with approved processes.

## Substation Equipment Maintenance Requirements

### 2 Substation Maintenance and Construction (SM&C) Manual

- 2.1 The booklets in the [SM&C Manual](#) provide procedures, recommended actions, and general specifications to inspect, test, and maintain substation equipment. These booklets are the result of extensive investigation into good utility practices, manufacturers' recommendations, and the experience of PG&E employees. Compliance with the information in the booklets ensures uniformity in performing procedures and supports system reliability.
- 2.2 Deviations
1. Deviating from the procedures in the [SM&C Manual](#) booklets is allowed only if the first-line supervisor obtains approval from the local transmission field specialist before proceeding. Use [Form TD-3322M-F90, "SM&C Manual Procedure Variance Review,"](#) to request a procedure variance.
  2. The local transmission field specialist reviews [Form TD-3322M-F90](#) and determines if the variance is acceptable. Attach the approved [Form TD-3322M-F90](#) to the test form for the specific equipment and place it in the equipment file.
  3. Document the variance in the long-text field of the SAP order for the maintenance work. State the nature of the deviation and reference the approved [Form TD-3322M-F90](#).
  4. The specialist approving the variance stores a copy of the completed [Form TD-3322M-F90](#) and associated SM&C equipment test form in the Work Methods and Procedures [Specialist Variance Acceptance](#) folder.
    - a. The naming convention for stored documents is: *Station Name/Equipment ID/Work Task/Date*.

**Example:** Los Banos/CB 922/Mechanism Service/5-10-2019

### 2.3 Training and Access

1. Any employee or supervisor involved in maintaining substation equipment must be trained on and have access to the information in the [SM&C Manual](#).

### 3 Recordkeeping

- 3.1 Records must be created and retained to meet the minimum requirements specified in [Corporation Standard GOV-7101S, "Enterprise Records and Information Management Standard,"](#) and any additional requirements of applicable regulations.
- 3.2 Retain **all** maintenance and inspection records for a minimum of 7 years from the date of the maintenance activity, in accordance with [GOV-7101S, Attachment 1, "Information and Records Retention Schedule,"](#) Section UOP21, Utility Maintenance – Routine Daily Operations. In addition, for regulatory requirements, retain records for all time-based maintenance activities for at least the past two maintenance occurrences.

## Substation Equipment Maintenance Requirements

### 3.2 (continued)

**Examples:** A 4-year mechanism service record must be retained until after the third service occurs, or approximately 8 years, depending on the exact date of the most recent service. An 8-year mechanism service record must be retained for 16 years, and a 12-year spare transformer test record must be retained for 24 years.

### 3.3 Include the following information in each record:

- Identification of responsible person
- Date of inspection or maintenance performance
- Asset affected
- Inspection findings (issue or condition) or description of maintenance work performed
- Priority rating or planned date of any corrective action needed

### END of Requirements

## DEFINITIONS

See [Attachment 2, "Definitions of Terms."](#)

## IMPLEMENTATION RESPONSIBILITIES

The director responsible for substations performs the following tasks:

- Issues this standard.
- Delegates authority to the manager responsible for substation standards to handle the attachments to this standard and updates to the [SM&C Manual](#).

The manager responsible for substation standards performs the following tasks:

- Revises, approves, and issues the attachments to this standard.
- Revises, approves, and issues, with assistance from the substation work methods group, the booklets contained in the [SM&C Manual](#).

Substation maintenance superintendents and first-line supervisors ensure that their employees understand and comply with this standard and follow the procedures in the [SM&C Manual](#).

Employees alert their supervisors to any unsafe procedures or instructions that may cause personal injuries or damage equipment. **Employees may only perform the work for which they have been trained.**

## Substation Equipment Maintenance Requirements

### GOVERNING DOCUMENT

NA

### COMPLIANCE REQUIREMENT / REGULATORY COMMITMENT

This standard supports the following compliance requirements and regulatory commitments:

- [CAISO Transmission Control Agreement, Appendix C, "ISO Maintenance Standards"](#)
- [CPUC General Order 174, "Rules for Electric Utility Substations"](#)
- [NERC Standard MOD-025-2, "Verification and Data Reporting of Generator Real and Reactive Power Capability and Synchronous Condenser Reactive Power Capability"](#)
- [NERC Standard PRC-005-6, "Protection System, Automatic Reclosing and Sudden Pressure Relaying Maintenance"](#)
- [WECC Standard FAC-501-WECC-2, "Transmission Maintenance"](#)

#### Records and Information Management:

PG&E records are company assets that must be managed with integrity to ensure authenticity and reliability. Each Functional Area (FA) must manage records and information in accordance with the Enterprise Records and Information Management (ERIM) policy, standards, and Enterprise Records Retention Schedule (ERRS). Each FA is also responsible for ensuring records are complete, accurate, verifiable and can be retrieved upon request. Refer to [GOV-7101S, "Enterprise Records and Information Management Standard,"](#) for further records management guidance or contact ERIM at [Enterprise\\_RIM@pge.com](mailto:Enterprise_RIM@pge.com).

### REFERENCE DOCUMENTS

#### Developmental References:

[Utility Procedure TD-3322P-02, "Preparing and Submitting Maintenance Practices to the CAISO"](#)

#### Supplemental References:

[Corporation Standard GOV-7101S, "Enterprise Records and Information Management Standard"](#)

- [Attachment 1, "Information and Records Retention Schedule"](#)
- [Form TD-3322M-F90, "SM&C Manual Procedure Variance Review"](#)
- [Form TD-3322M-F104, "Maintenance Deferral Notification to CAISO"](#)

## Substation Equipment Maintenance Requirements

### REFERENCE DOCUMENTS (continued)

[Substation Maintenance and Construction \(SM&C\) Manual \(TD-3322M\)](#)

[Utility Procedure TD-3320P-12, "Substation SAP Work Management System \(WMS\) Process"](#)

### APPENDICES

NA

### ATTACHMENTS

[Attachment 1, "Communication Flowchart"](#)

[Attachment 2, "Definitions of Terms"](#)

[Attachment 3, "Deferring Preventive Maintenance"](#)

[Attachment 4, "Arrestors, Bushings, and Insulators Maintenance Template"](#)

[Attachment 5, "Station and Headquarters Maintenance Template"](#)

[Attachment 6, "Station Direct Current Supply Maintenance Template"](#)

[Attachment 7, "Circuit Breaker Maintenance Template"](#)

[Attachment 8, "Transformer and Load Tap Changer \(LTC\) Maintenance Template"](#)

[Attachment 9, "Reactive Component Maintenance Template"](#)

[Attachment 10, "Air Switches, Motor-Operated Air Switches, and Circuit Switchers Maintenance Template"](#)

[Attachment 11, "PG&E Substation Inspection Program Summary"](#)

[Attachment 12, "Inspecting and Maintaining Distribution Equipment Inside Substations"](#)

[Attachment 13, "Substation Spare Transformer/Reactor Testing"](#)

### DOCUMENT REVISION

This utility standard cancels and supersedes Utility Standard TD-3322S, "Substation Equipment Maintenance Requirements," Rev. 9, dated 08/03/2023.

### DOCUMENT APPROVER

██████████, Director, Substation Maintenance and Construction

### DOCUMENT OWNER

██████████ Manager, Substation Standards

## Substation Equipment Maintenance Requirements

### DOCUMENT CONTACT

██████████ Senior Electric Standards Engineer

### REVISION NOTES

When/Where?	What Changed?
<b>August 2015</b>	
Summary and Safety	Moved safety statement to Summary section.
Section 1.1	Revised title, described function of maintenance plans and WMS, and added reference to Utility Procedure TD-3320P-12.
Section 1.3	Added detail to specify when an activity (both preventive and corrective) is out-of-compliance.
Section 2.2	Made minor edits.
Implementation	Changed issuer to the senior director.
Reference Documents	Added TD-3320P-12; deleted SAFE-1001S and FAC-501-WECC-1.
Approver	Changed to senior director of substations.
Attachments	Edited Attachment 12 (originally published 07/01/2014; made minor edits 06/29/2015). Updated Attachments 2, 4, 5, 6, 9, and 10 (published 12/2014) and Attachments 7 and 8 (published 05/01/2015).
<b>July 2016</b>	
Section 2.1	Incorporated Utility Bulletin TD-3322B-022.
Attachments	Updated attachments and created new Attachment 13: <ul style="list-style-type: none"> <li>Attachment 5 – Added information from Utility Bulletin TD-3322B-026 and fire systems information.</li> <li>Attachment 7 – Added GIS density monitor.</li> <li>Attachment 8 – Revised LTC through neutral.</li> <li>Attachment 10 – Added Table 3, per Utility Bulletin TD-3322B-027.</li> <li>Attachment 13 – Incorporated information from Utility Bulletin TD-3322B-42.</li> </ul>

## Substation Equipment Maintenance Requirements

REVISION NOTES (continued)

What/Where?	What Changed?
<b>October 2017</b>	
1.3.2. Batteries	Updated NERC Standard revision number and title. Corrected error in Table 2 for Next Out-of-Compliance Date from 2016 to 2017.
Compliance Requirement	Added NERC MOD-025-2.
Attachments	<ul style="list-style-type: none"> <li>• Revised the following attachments:               <ul style="list-style-type: none"> <li>○ Attachment 4 – Added section and Tables 3 and 4 to incorporate insulator wash requirements from Utility Bulletin TD-3322B-044.</li> <li>○ Attachment 6, Table 1 – Changed “monthly” to “scheduled” in various battery maintenance items. Added item for battery charger testing (ETS47).</li> <li>○ Attachment 7, Table 1 – Breaker overhaul, changed operations trigger from 4000 to 3000 (Nov. 2016); revised exercise requirements, deleted functional performance test and updated Mech Service, all per Utility Bulletin TD-3322B-060. Clarified the overhaul activity.</li> <li>○ Attachment 8, Table 1 – LTC Through Neutral: Added additional tap changer types (Nov. 2016); revised language on LTC through neutral on oil diagnostics – added requirement for new in-service transformers, per Utility Bulletin TD-3322B-059.</li> <li>○ Attachment 9, Table 1 – Added item (ETS11) to verify synchronous condenser capabilities, per NERC MOD-025-2 and Utility Bulletin TD-3322B-056.</li> <li>○ Attachment 10, Table 3 – Added Eureka A and Eureka E.</li> </ul> </li> <li>• Corrected various booklet page references in the above attachments.</li> </ul>
<b>July 2018</b>	
Standard and Attachments	<ul style="list-style-type: none"> <li>• Performed annual review. No material changes to the standard. (Made some editorial changes updated links in many references to the TIL Viewer.)</li> <li>• Attachment 5, Table 1 – Changed the yearly requirement for hot stick dielectric testing and visual inspection to a 2-year frequency, reworded the visual inspection to add clarity (January 2018).</li> <li>• Attachment 6, Table 1 – Clarified battery test descriptions in the Maintenance Task column. Excluded batteries with monitoring systems from the resistance test. Added a task to periodically prove alarms on battery monitoring systems.</li> <li>• Attachment 7, Table 1 – Exercise task, changed “bi-annually” to “biennially” to clarify task occurs every 2<sup>nd</sup> year.</li> </ul>

## Substation Equipment Maintenance Requirements

REVISION NOTES (continued)

When/Where?	What Changed?
<b>November 2019</b>	
Standard	<ul style="list-style-type: none"> <li>• Section 3, “Recordkeeping” – Updated recordkeeping requirements.</li> <li>• Implementation Responsibilities – Revised process for updating the SMC Manual.</li> <li>• Compliance Requirements – Updated FAC-501-WECC to Rev 2.</li> <li>• Updated Document Approver.</li> </ul>
Attachments	<ul style="list-style-type: none"> <li>• Attachment 3 – Document was mostly rewritten. Clarified that NERC-designated batteries cannot be deferred. Simplified Table 2. Deleted Appendix A and converted Appendix B to Form TD-3322M-F104.</li> <li>• Attachment 6, Tables 1 and 2 – Changed “Discharge test” to “Battery capacity test” and updated references to match latest revision of the Battery booklet.</li> <li>• Attachment 7, Table 1, ETS56 – Added time-based trigger to perform analysis as part of a mechanism service. Also, published in April 2019, Table 1, ETS28 – Removed 3-year mechanism service requirement for transmission breakers at DCPD switchyard. Under the 8-year cycle, added an exclusion for transmission breakers with a 12-year cycle. Under the 12-year cycle, added all MEPLI transmission class breakers, except those with air compressors.</li> <li>• Attachment 11, “SmartMeter Equipment Maintenance,” – Cancelled/ Obsolete. There is no ongoing maintenance required for obsolete SmartMeter equipment.</li> <li>• Attachments 12 and 13 – Renumbered “Attachment 12” to “Attachment 11.” Renumbered “Attachment 13” to “Attachment 12.”</li> </ul>
<b>October 2020</b>	
Section 1.3.3 and Table 3	Changed closure of Priority A tags to no more than 30 days, per Utility Bulletin TD-8123M-B001.
Tables 1, 2, 3	Advanced the dates by 2 years to the 2020 timeframe.
Compliance Requirement / Regulatory Commitment	Added “Records and Information Management” information to this section, which is now required in all standards.
Attachments	<ul style="list-style-type: none"> <li>• Attachment 4 – Moved material related to station wash to Attachment 5. Published 4/22/20.</li> <li>• Attachment 5 – Added material related to station wash from Attachment 4, revised criteria for inspection, contamination monitoring, and wash related to DCPD-critical facilities. Published 4/22/20</li> <li>• Attachment 7 – Clarified on which breakers BGA™ is performed under “Overhauls;” added line for “5,000 operations for all GIS CBs.”</li> <li>• Attachment 9 – Added several items for series capacitors, annual inspection. Under Table 2, “Animal abatement,” added item for series caps optical gel.</li> <li>• Attachment 10 – Clarified 5-year trigger is for air type MOAS; added 8-year and 12-year triggers for GIS type MOAS.</li> </ul>

## Substation Equipment Maintenance Requirements

### REVISION NOTES (continued)

When/Where?	What Changed?
<b>March 2022</b>	
Sections 1 and 2	<ul style="list-style-type: none"> <li>• Changed “basic finish date” to “required end date” and “past-due date” to “out-of-compliance” date.</li> <li>• Changed F priority notifications to 2 year out-of-compliance date from “None.”</li> </ul>
Section 3.2	Revised minimum record retention requirement from 6 years to 7 years.
Attachments	<ul style="list-style-type: none"> <li>• Attachment 5 – Table 1: Added SF6 monitors and Hydrogen Gas Detectors; Fire Systems, deleted references to CO2 systems (none are installed). Table 2: Added SF6 monitors and Hydrogen Gas Detectors. (Published 5/28/21)</li> <li>• Attachment 7 – Page 1, Added reference to NERC FAC-501-WECC-2.</li> <li>• Attachment 8 – Table 1 (TDA and Oil quality): Changed sampling rate for all oil-filled equipment to annual; updated form references; added task to rotate Alternate spares into service. Table 2: Changed PCB references to ENV-4100P-01.</li> <li>• Attachment 9 – Table 1 Station Inspections, minor revisions to account for new STATCOM; Series Capacitor Annual, added Tesla SC2 for optical gel; STATCOM Annual, deleted two items and added item to replace coolant filter cartridges and cleaning strainer; STATCOM, Added task for infrared scanning; STATCOM 3-year, Removed two items and added item to change controller batteries; STATCOM 5-year, Changed trigger from 6 to 5 years, deleted battery replacement, added item on hoses, seals and joints, added inspection of grading electrodes.</li> <li>• Attachment 10 – Page 1: Added reference to NERC FAC-501-WECC-2.</li> <li>• Attachment 11 – Page 1: Added reference to NERC FAC-501-WECC-2.</li> </ul>
Document Owner and Document Contact sections	Updated names and titles.
<b>January 2023</b>	
Section 1.3 Table 4	Changed “F” priority notification out-of-compliance date to “None” for corrective work.
<b>June 2024</b>	
Attachments	Added Attachment 13