

Substation Animal Abatement Measures

SUMMARY

This utility procedure describes PG&E’s Animal Abatement Program for electric substations, including distribution and other equipment inside the fence.

The Animal Abatement Program was designed to improve reliability by mitigating outages due to animal and bird contacts within substations.

Level of Use: Informational Use

TARGET AUDIENCE

Substation maintenance and construction (M&C), asset strategy, and project engineering personnel.

SAFETY

This procedure describes minimum administrative tasks and does not raise the risk of a specific hazard to personnel, the public, or equipment.

BEFORE YOU START

NA

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PROCEDURE STEPS

1 General Information

- 1.1 Animal-related outages are one of the leading causes of substation outages and equipment damage.
- Between the years 2000 and 2009, 200 animal contacts were reported.
 - The Capital Animal Abatement Program was started in 2009.
 - As of December 2013, animal abatement was completed at 222 substations.
 - In 2016 (due to an increase in animal contacts in 2013 after abatement measures were taken), additional design mitigations were included to broaden the mitigation impact.
- 1.2 Lagging Indicator – The key philosophy behind previous animal abatement measures has been that the level of animal activity dictates the level of abatement. Recent animal contact is a lagging indicator and requires immediate action to avoid a repeat incident.
- 1.3 Leading Indicator – Since 2012, new construction requires animal mitigation measures. BE OBSERVANT AND USE common sense to prevent outages by looking for the following leading factors indicating animal abatement is needed:
- Increased animal activity due to adjacent lands under construction.
 - Close to a river, creek, heavily wooded area, or foothills.
 - Evidence of animal activity found during monthly substation reads (e.g., nesting in equipment, burrowing, or carcasses).
 - Locations within substations that have less-than-standard conductor clearances. (SEE [Numbered Document 067908, “Outdoor Electrical Clearance Distances for Transmission and Distribution Substations.”](#))

2 Targeted Equipment

- 2.1 INCLUDE animal abatement in all new construction AND major reconstruction projects (i.e., transformer replacements, bus conversions).
- 2.2 The overall mitigation goal is to move toward engineered, molded covers for all equipment. The following guidance is provided in order of priority:
1. Standard Application – Whenever possible, USE engineered, molded covers.

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2.2 (continued)

2. Special Application:

- a. IF it is not possible to use molded covers due to legacy equipment,

THEN USE an alternate abatement method. USE taping only as a last resort.

2.3 An analysis of animal contacts from the years 2000 through 2009 shows most contacts occur on equipment rated 35 kilovolts (kV) or lower and are caused primarily by squirrels, birds, and cats. Lower voltage equipment is more vulnerable to animal contact due to the smaller physical distances between phase-to-phase and phase-to-ground voltages.

2.4 Distribution – Historically, the most extensively damaged PG&E equipment is distribution class breakers and regulators, which can result in large customer outages and equipment damage to the extent that emergency replacement is required. Tree squirrels are the most frequent cause of distribution contacts.

2.5 Transmission – For transmission level voltages, the most frequent cause is bird contacts. Mitigation measures for equipment rated below 35 kV include abating the tertiary bus conductor, bus support locations, potential transformers (PTs), current transformers (CTs), station service transformers, and lightning arrestors. Ensuring that the perimeter fence is intact, without gaps at the bottom and no overhanging vegetation, is important as the first level of defense against ground animals.

3 Mitigation Techniques

3.1 Mitigation Options

1. Bait Traps – Installed within the substation fence by licensed pest control companies to reduce the number of animals within the substation.
2. Climbing Guards – 40-mil plastic sheet material with slick surface used on wood or steel poles to prevent squirrels from climbing poles to reach energized conductors (Code 560336 for 30-inch x 100-foot [ft] roll). Also minimizes perching and climbing access.
3. Physical Separation – When planning new installations, PROVIDE separation as follows:
 - a. DESIGN additional phase-to-ground AND phase-to-phase clearances in locations with high animal activity.
 - b. REPLACE insulators that are shorter than standard height with insulators greater than normal height.

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3.1 (continued)

4. Electric Fence – Electric fences are effective for ground-traveling animals.
 - a. Equipment must be completely enclosed to be effective.
 - b. Overhead distribution lines entering a protected bus must have devices installed to block animals traveling on lines (SEE Item 8 below regarding rotating tube barriers).
 - c. Electric fences are not effective for contact caused by birds; these fences complicate access to equipment for some switching and maintenance activities.
5. Insulating Tape and Covers – USE on conductors up to 25 kV phase-to-ground.
 - a. Tape is effective for both ground animals and birds.
 - b. USE only approved heat-shrink tape.
 - c. Insulating tape and covers must cover all exposed metal, and never cover sight glass, or more than the first skirt of any bushing or insulator.
 - d. SEE [TD-3322M](#), “[Substation Maintenance and Construction \(SM&C\) Manual](#),” General Information booklet, Section 7, “Animal Abatement Materials,” for approved products and installation instructions.
6. Nesting Locations – Nests within substation equipment increase the risk of contact in three ways: 1) bird contacts; 2) contact caused by nesting material; and 3) contact caused by animals looking for nests.
 - a. REMOVE inactive nests within substation equipment.
 - b. BLOCK OR SEAL locations commonly used for building nests. USE knockout seals (shown on [Numbered Document 052647](#), “[Knockout Seals](#)”) to close drain holes in tubular bus structures.
 - c. REMOVE nesting material supplies, when possible.
7. Raptor-Safe Construction – [Numbered Document 061149](#), “[Raptor Safe Construction and Wildlife Protection](#),” describes the materials and methods used in overhead distribution and transmission line construction to protect against animal contact.
8. Rotating Tube Barriers for Conductors (“Critter Guards”) – When installed on overhead distribution lines entering a substation, these devices prevent squirrels from using overhead conductors to enter a substation. Critter Guards are required in conjunction with all electric fences to block animals from entering equipment within an electric fence.

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3.1 (continued)

9. Vegetation Management – Reducing or removing vegetation can reduce cover and habitat for animals adjacent to a substation.
 - a. REMOVE vegetation over-hanging or in contact with substation fences to reduce access paths for animals entering substations ([TD-3322M](#), Section, “Substation Inspections,” Subsections V.A.3 and V.A.4, address this issue in the context of human concern only).
10. Stored Equipment – Minimizes the time that stored equipment remains within a substation in shipping crates or boxes.
 - a. REMOVE shipping crates OR boxes to reduce nesting or hiding places for animals entering substations ([TD-3322M](#), Section, “Substation Inspections,” Subsection V.A.6, addresses this issue in the context of human concern only).
11. Methyl Anthranilate (MA) Gas (“Bird Buffer”) – The timed dispersion of MA gas mist (from grape seed oil) has proven effective to deter flocking birds from nesting and congregating inside of substations. (This equipment is acquired through the capital tools budget.)

3.2 Proactive Actions

1. Distribution Breaker Protection
 - a. ORDER AND INSTALL bushing terminal covers/hoods AND lead wire covers on each new capacity and replacement distribution feeder breaker. (SEE [Numbered Document 4030447, “Typical Arrangement of 12/21 kV Switch & Bus Structure Main and Auxiliary Bus \(Low Profile\),”](#) and [Numbered Document 4030449, “Typical Arrangement of 12/21 kV Switch & Bus Structure Double Bus \(Low Profile\),”](#) for details.)
2. Substation Protection
 - a. PERFORM animal abatement in conjunction with distribution substation projects.
 - (1) IF adding new or replacing banks, breakers, circuit switchers, mobile breaker, mobile transformer, air switches or regulators,

THEN INCLUDE animal mitigation on distribution voltage connections AND tertiary bus connections.

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3.2 (continued)

3. Bus-Tie and Regulator Air Switches
 - a. IF physically possible and it does not interfere with switch operation,

THEN INSTALL plastic barrier discs on distribution bus-tie switches to avoid outages that affect bus sections for multiple banks.
 - (1) After installing animal abatement equipment on or near link-operated switches, OPERATE the switches to ensure free movement over the switch's entire range, from fully open to fully closed before energization.
 - b. INSTALL plastic barrier discs on switches associated with regulators and low-side bank spare (bus-tie) breakers. ([TD-3322M](#), General Information booklet, Subsection 7.VI, provides photos and ordering information for plastic barrier discs.)
 - (1) After installing animal abatement equipment on or near link-operated switches, OPERATE the switches to ensure free movement over the switch's entire range, from fully open to fully closed before energization.

3.3 Levels of Abatement

1. Distribution – PROTECT the following distribution equipment (35 kV or lower) by a minimum separation distance of 24 inches (for both phase-to-phase and phase-to-ground clearances):
 - a. Circuit breaker bushings.
 - b. Regulator bushings and arresters – For source-to-load connected arresters, COVER the entire arrester if it is infeasible to cover only the stud connections.
 - c. PTs – Abatement of underhung PTs is required.
 - d. Bus-mounted CTs – This does not apply to neutral CTs.
 - e. Switchgear wall/roof bushings.
 - f. Transformer medium voltage (MV) (low side) and tertiary bushings – COVER the bus insulator at the first support away from the transformer AND COVER any unconnected (floating) bushings.
 - g. There are some legacy facilities with a typical MV or tertiary bus orientation in a vertical arrangement – COVER these busses to provide a 24-inch separation between the phases.

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3.3.1 (continued)

- h. Substation service transformer primary bushings. (Secondary connections do not require abatement.)
 - i. Fused disconnect switches – There are three different standard configurations for this switch, per [Numbered Document 333122, “Requirements for S&C Company 23 kV Type SMD-20 Power Fuse Mounting.”](#) and sometimes differing insulator types.
 - j. Potheads – Exposed electrical conductors connected to riser potheads, leave just enough room for temporary grounding when abating potheads. The first post insulator for buswork extending to the pothead must also be abated, as well as any single insulators for a line PT. (Due to grounding safety concerns with close proximity, potheads installed on pipe-type structures [Westinghouse] do not require protection.)
 - k. Bus-tie switches (includes bank switches) – COVER the buswork where necessary within 4 feet of the bus spans from the switch AND the first bus support insulator if it is within 4 feet spacing from the switch.
 - (1) After installing animal abatement equipment on or near link-operated switches, OPERATE the switches to ensure free movement over the switch’s entire range, from fully open to fully closed before energization.
 - l. Neutral reactors – COVER the conductor (tubing) termination coming from the bank neutral bushing. Even though this fault current-limiting reactor is grounded, there is still elevated potential during neutral currents.
 - m. Shunt capacitor banks (typically connected to feeders) – COVER the recloser bushings, any PTs and leads, AND the bus support insulators below the capacitor frame (frame insulator, due to concerns of neutral contacts).
 - n. Distribution wood poles – INSTALL an animal climb guard (Code M560336) to all poles inside and immediately outside the substation fence.
 - (1) INSTALL a climb guard around wood poles at a minimum elevation of 4 ft.
2. Transmission – The following transmission equipment (35 kV or lower) must be protected by a minimum distance of 24 inches (for both phase-to-phase and phase-to-ground clearances):
- a. Tertiary bushings, surge (lightning) arresters, and tertiary bus support insulators. COVER any unconnected (floating) bushings.
 - b. Substation service transformer primary bushings. (Secondaries are not required.)

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3.3.2 (continued)

- c. Fused disconnect switches – There are three standard configurations for this switch, per [Numbered Document 333122](#), and sometimes differing insulator types.
3. Additional Items for Site Review (Substation-Wide)
 - a. Vegetation management techniques in removing animal habitat and vegetation growing through or over substation fences.
 - b. Animal entrances through drainage systems.
 - c. Fence repair or modifications and grading or fill rock to prevent burrowing-type animal entry through gaps larger than 2 inches. (Exceptions to this rule are gaps for gates or isolation panels.)
 - d. Exposed structural beam ends where closure caps have not been installed.
 - e. Fabrication holes (drain holes) in structural steel requiring knockout covers.
 4. Grounding Concerns – Application of animal guards must provide adequate space for installing safety grounds.
 - a. MAINTAIN sufficient exposed bare conductor, OR INSTALL grounding lugs, where required.
 5. Electric Fence – An alternative method to insulating tapes, boots, and sleeves is an electric fence enclosing the targeted equipment.
 - a. Only USE this method if the contact history or risk at this location is due to ground-based animals (not bird contacts).
 - b. WHEN an electric fence is installed,

THEN INSTALL Critter Guards on overhead line take-offs from the protected bus to block animal access from overhead lines.
 - c. INSTALL an electric fence as a secondary level of protection around distribution busses at a substation when any of the following circumstances exist:
 - There is less than standard bus spacing separation.
 - There are an excessive number of disconnect switches.
 - Ground animals have bypassed the standard abatement material and caused multiple contacts.

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3.3 (continued)

6. The abatement measures described in [Section 3.3, "Levels of Abatement,"](#) starting on Page 6 of this procedure are mandated for all substations that experience an outage or equipment damage related to animal contact.
7. IF a substation has incurred equipment damage AND requires a capital job to replace damaged equipment,

THEN INCLUDE abatement work with the capital equipment replacement job.

4 Initiating Work

- 4.1 The local maintenance supervisor WORKS with the M&C engineer to determine the level of animal abatement necessary for each substation AND then INITIATES the work.
- 4.2 CLASSIFY the substation that requires animal abatement based on the wildfire risk described in [Utility Bulletin TD-3322B-066, "Substation Wildfire Safety Inspection Program."](#)
- 4.3 INITIATE the animal abatement work by high fire threat district (HFTD) tiers:
 1. HFTD Tier 3, Tier 2, and Tier 2A/3A:
 - a. PG&E's goal is to abate all substations in Tier 3, Tier 2, and Tier 2A/3A as soon as possible.
 - b. IF the SM&C inspection team FINDS a station that has not been abated,

THEN ABATE the substation under capital funding. Substation asset management SPONSORS the funding. DO NOT CREATE LC notification. SEE [Section 5.2](#) on Page 11.
 - c. IF SM&C inspection team FINDS a station that is partially abated,

THEN CREATE LC notification for each piece of unabated equipment under expense funding. ENSURE the local maintenance headquarters funds AND performs the work using corrective expense. SEE [Section 5.1](#) on Page 11.
 2. HFTD Tier 1:
 - a. Substation asset strategy personnel REVIEW the list provided by the M&C inspection team AND CROSS-REFERENCE that list with the abated and 5-year plan replacement lists.
 - b. Substation asset strategy personnel NOTIFY whether the station has already been abated OR if it is already on the 5-year plan replacement list.

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4.3 2 (continued)

- (1) IF the identified substation shows as abated,

THEN CREATE a LC notification for the unabated equipment under expense funding. ENSURE the local maintenance headquarters funds AND performs the work using corrective expense. SEE [Section 5.1](#) on Page 11.
- (2) IF the identified substation has not been abated AND it is not on the abated or 5-year replacement lists,

THEN substation asset strategy personnel ADD the substation for prioritization work. DO NOT CREATE LC notification. The work will be performed under capital funding.

4.4 The frontline supervisor CREATES a SAP/Work Management System (WMS) notification AND EMAILS the substation asset strategy supervisor that the notification has been submitted.

4.5 IF funding is immediately available,

THEN the substation asset management supervisor RELEASES the notification.

1. IF funding is not available for the current calendar year,

THEN substation asset strategy personnel ADDS the notification/nomination to the list of substations that need animal abatement in the future.

4.6 For distribution substations, the entire substation must be abated. SEE [Section 3.3](#) on Page 6 for the level of abatement required for distribution substations.

4.7 For transmission substations, INSTALL the minimum abatement level on all equipment below 21 kV, such as the tertiary transformer bushings, tertiary bus, and substation service transformers.

1. IMPLEMENT additional abatement measures on a case-by-case basis for unique issues such as flocking birds or high-voltage contacts.

4.8 Substation asset strategy personnel may INITIATE work as a result of reviewing event and reliability reports.

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5 Funding Work

5.1 Expense Funding

1. Funding animal abatement for one piece of equipment is considered expense work.
2. The local maintenance headquarters FUNDS partial animal abatement to the substation using corrective expense funds.

5.2 Capital Funding

1. Installing or replacing animal abatement for an entire substation or “substation set” is considered a unit of capital under major work category (MWC) = 48 for Distribution or MWC = 66 for Transmission. SEE the Retirement Unit Catalog (available on the Capital Accounting SharePoint site) under the following asset classes: ETP35301 (Transmission) or EDP36200 (Distribution).
2. Work initiated immediately following an animal-related outage is funded by one of the following emergency MWCs: MWC = 59 for distribution substations and MWC = 65 for transmission substations.
3. Substation asset management FUNDS all capital substation work.
4. Substation M&C FUNDS capital tools such as the Bird Buffer.

6 Animal Contact List

- 6.1 The substation asset strategy group MAINTAINS a list that details historical animal contacts in substations used for project development. They also TRACK the substations that have been abated and audited for completeness to develop a 1-N ranked list of remaining transmission and distribution substations for future abatement.
- 6.2 The substation asset strategy reliability group RANKS unabated substations by criticality.
 1. BASE criticality on the number of customers potentially impacted, number of transformer banks, and the risk of animal contact.
 2. Substation asset strategy MAINTAINS AND COMMUNICATES the list.
- 6.3 Substation asset management REQUESTS funding for the 5-year investment plan AND COMMUNICATES to M&C engineers and substation M&C personnel when the work will be released for implementation each year.

END of Instructions

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DEFINITIONS

Major work category (MWC): A PG&E accounting term for budget allocation and tracking, based on the type of work performed.

SAP Work Management System (SAP/WMS): The computerized database used to manage substation maintenance activities.

IMPLEMENTATION RESPONSIBILITIES

Substation asset management (strategy engineers and implementation engineers), project engineers, construction engineers, maintenance and construction engineers, and maintenance personnel are required to understand and follow this procedure.

GOVERNING DOCUMENT

[Utility Standard TD-3350S, "Substation Asset Strategy and Reliability"](#)

COMPLIANCE REQUIREMENT / REGULATORY COMMITMENT

Records and Information Management:

The document owner, or designee, ensures any records generated by this procedure are maintained in accordance with the Enterprise Records and Information (ERIM) program policy, standards, and Enterprise Records Retention Schedule (ERRS). Refer to [GOV-7101S, "Enterprise Records and Information Management,"](#) and related standards.

Management of records includes, but is not limited to:

- Integrity
- Storage
- Retention and Disposition
- Classification and Protection

REFERENCE DOCUMENTS

Developmental References:

[IEEE Standard 1264-2015, "Guide for Animal Deterrents for Electric Power Supply Substations"](#)

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REFERENCE DOCUMENTS (continued)

Numbered Documents:

[052647, "Knockout Seals"](#)

[061149, "Raptor Safe Construction and Wildlife Protection"](#)

[067908, "Outdoor Electrical Clearance Distances for Transmission and Distribution Substations"](#)

[333122, "Requirements for S&C Company 23 kV Type SMD-20 Power Fuse Mounting"](#)

[4030447, "Typical Arrangement of 12/21 kV Switch & Bus Structure Main and Auxiliary Bus \(Low Profile\)"](#)

[4030449, "Typical Arrangement of 12/21 kV Switch & Bus Structure Double Bus \(Low Profile\)"](#)

[Retirement Unit Catalog](#)

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

- [General Information booklet](#), Section 7, "Animal Abatement Materials," Subsection 7.VI
- [Substation Inspections section](#), Subsections V.A.3, V.A.4, and V.A.6

[Utility Bulletin TD-3322B-066, "Substation Wildfire Safety Inspection Program"](#)

Supplemental References:

- Bird-X: <http://www.bird-x.com/>
- Bird Buffer: <http://birdbuffer.com/>
- Critter Guard, Inc.: <https://www.critterguard.org/>
- GreenJacket: www.greenjacketinc.com
- Kinectrics Non-Electric Fence: **Call (416) 732-3492**
- Midsun Group: <http://www.midsungroup.com/>
- TE Connectivity: <http://energy.tycoelectronics.com>
- TransGard: <http://www.transgardfence.com/>

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APPENDICES

NA

ATTACHMENTS

[TD-3350P-10-JA01, "Tape Installation Job Aid"](#)

[TD-3350P-10-JA02, "Animal Abatement Job Aid"](#)

[TD-3350P-10-JA03, "Working with Switch Cover Kit"](#)

[TD-3350P-10-JA04, "Ensuring Switch Target Plate Visibility with Barrier Discs Installed"](#)

DOCUMENT REVISION

This utility procedure cancels and supersedes the following documents:

- Utility Procedure TD-3350P-10, "Substation Animal Abatement Measures," Rev. 6, dated 10/07/2020.
- TD-3350P-10 Guidance Tailboard, publication date 05/05/2015.

DOCUMENT APPROVER

██████████ Manager

DOCUMENT OWNER

██████████ Manager

DOCUMENT CONTACT

██████████ Principal

██████████ Engineer

REVISION NOTES

Where?	What Changed?
Attachments	Additional documents were added to the Attachments section: <ul style="list-style-type: none"> • TD-3350P-10-JA03, "Working with Switch Cover Kit" • TD-3350P-10-JA04, "Ensuring Switch Target Plate Visibility with Barrier Discs Installed"