



PLANNING GUIDE FOR SINGLE CUSTOMER SUBSTATIONS SERVED FROM TRANSMISSION LINES 055103

Department: Electric T&D **Section:** T&D Engineering and Technical Support

Approved by: G.O. Duru (GOD1)  **Date:** 01-30-06

Rev. #01: This document replaces PG&E Document 055103, Rev. #00. For a description of the changes, see Page 7.

This document is also included in the following manuals:

- *Electric and Gas Service Requirements Manual* ("Greenbook")
- *Electric Planning Manual*

Purpose and Scope

1. This document specifies the requirements and preferred method of serving single customer substations from transmission lines.
2. This substation planning guide is only applicable to single customer (PG&E owned) substations where the service delivery voltage is over 2,000 volts and the magnitude of the applicant's load is such that PG&E has elected, for its operating convenience and necessity, to supply the load from transmission sources. This will require the installation of a substation on the applicant's premises under the provisions of Section D of PG&E's Electric Rule No. 2 and Section C of PG&E's Electric Rule No. 16.
3. The applicant's service may be either overhead or underground. A typical overhead service is shown in Figure 1 on Page 5, and a typical underground service is shown in Figure 2 on Page 6. The illustrations on Pages 5 and 6 of this document are general and are intended for preliminary planning purposes only.

General Information

4. The applicant shall, at his or her expense, obtain all land use, environmental impact, and necessary building permits.
5. It is the applicant's responsibility to install and maintain all related substation site improvements in accordance with the requirements of PG&E and those of federal, state, and local agencies.
6. The applicant shall, at his or her expense, furnish, construct, and maintain the following site improvements:
 - A. Fences and gates.
 - B. Paving and grading.
 - C. Paved access road.
 - D. Foundations, including embedded stubs and anchor bolts.
 - E. Conduits and pull boxes.
 - F. Grounding systems.
 - G. Landscaping required.
 - H. Oil retention facilities if required (as determined by PG&E or the applicant).Foundations, underground conduits, and grounds are to be installed as specified by PG&E. The applicant shall arrange to have PG&E inspect them during installation, while they are exposed. Foundation forms and anchor bolt settings are to be approved before concrete is poured.
Landscaping or oil retention facilities may be required by local, state, or federal agencies.
7. If an enlargement of an existing customer substation is to be made that will require construction to be done within the fence of the existing energized station, it may be necessary to either relocate the fence or have the actual construction work performed by PG&E at the applicant's expense. Ties to an existing ground grid are to be made by PG&E.
8. The applicant's design for grading, access road, and oil retention facility must be approved by PG&E prior to the start of construction.

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9. The applicant's service point is the terminal pad of a disconnect switch in the substation. The applicant shall terminate his or her electric service conductors with PG&E-approved flexible connectors to PG&E's copper switch pads. The connectors and tinned Everdur bolts (or equal) shall be furnished by the applicant and installed by PG&E. The applicant's equipment, except overhead service take-off lines, shall not be mounted on PG&E structures. Underground cable potheads shall be supported on a separate structure provided by the applicant.
10. Substation lighting poles and lighting fixtures will be furnished and installed by PG&E, including wiring. The applicant shall provide the required foundation and conduits for lighting poles as described in Note 6 on Page 1. If practical, lighting fixtures may be installed on substation structures.
11. Revenue metering transformers and meters will be provided and installed by PG&E. No other circuits or equipment shall be connected to the metering transformers, except with special written approval granted for unusual circumstances.

Where the applicant takes delivery at the secondary voltage level of the transformer, the applicant shall provide a cubicle which is dedicated for the installation of revenue metering transformers and meters. This metering cubicle shall be located in the applicant's switchgear, outside the fenced substation enclosure. The cubicle shall be designed to comply with PG&E's service requirement standards, and drawings shall be submitted to PG&E for approval prior to the manufacturer's fabrication.

Where the applicant takes delivery at the transmission voltage level and owns or leases the substation, metering shall normally be at the transmission voltage with the applicant providing the structures, foundation, and by-pass and disconnect switches for mounting and connecting the metering transformers. Meters shall be located in a building or cubicle provided by the applicant and accessible without entry into the fenced substation enclosure.

12. Services will normally be supplied from a grounded wye transformer. Services of voltages other than those shown on Table 1, are generally not available. Special consideration is necessary if 230 kV transmission voltage is required.

Table 1 Three-Phase MVA Ratings ¹

Nominal Transmission Voltage	Available Substation Secondary Voltage		
	4160Y/2400 V	12470Y/7200 V	21600Y/12470 V
	Three-Phase MVA Ratings (maximum)		
60 kV	10.5	12.5	12.5
70 kV	5.2	12.5	12.5
115 kV	10.5	45.0	45.0

¹ These ratings indicate the MVA size of emergency replacement transformers. Service to loads in excess of the values indicated requires special consideration.

13. The applicant shall install, adjacent to the substation, a power circuit breaker or a three-phase recloser on his or her main service conductor, or on each circuit supplied from the main service. The term "adjacent" means that only the substation fence separates the applicant's switchgear from the substation. If the applicant cannot locate his or her switchgear adjacent to the substation, the applicant shall provide a metering cubicle, and a power circuit breaker or a three-phase recloser, for his or her main service adjacent to the substation.
14. The applicant shall provide ground fault protection if:
 - A. Power circuit breakers or three-phase reclosers (specified in Note 13 above) serve overhead lines.
 - B. Ground fault limiting resistors or reactors are installed.

Ground fault protection is also recommended for underground cables.

The applicant's protective devices shall coordinate with PG&E's protective devices, and they shall clear every fault on the applicant's system.

15. Any underground conduits or piping extending outside of the fenced area of the substation yard shall be non-metallic to a distance of at least 8 feet.
16. On 3-wire services using metallic shielded underground high voltage cables to connect the substation to the applicant's equipment, the cable shield should be grounded **only** at PG&E's end and shall be insulated at the applicant's end. Shielded cable shall be installed in non-metallic conduit extending to a distance of at least 8 feet outside the substation fence.

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17. Where the applicant requests a ground fault limiting resistor in the transformer neutral located outside of the substation fenced area, the elevated neutral conductor shall be insulated for the operating voltage supplied. If the applicant requires a ground fault limiting resistor in the substation, the resistor and a resistor bypass switch will be installed by PG&E at applicant's expense.
18. If the applicant's equipment fence ground is bonded to his or her equipment ground grid, the fence must be separated from the substation fence by 8 feet. Use non-metallic 8-foot sections to cover the separations. If the applicant's equipment fence ground is not bonded to his or her equipment ground grid, the equipment fence must be separated from the substation fence by 6 inches.
19. The substation ground grid shall not be connected to the fence grounds or anything outside the substation. For details of ground grid installation and separation requirements of fence grounds, see Document 067910 and Document 020607.
20. The applicant shall be responsible for keeping the substation free of weeds and other debris.
21. The following data is to be supplied by the applicant to PG&E:
 - A. Prior to design completion:
 - (1) The applicant's service requirements, such as expected demand (MW), proposed service voltage, power factor, and ultimate growth requirements.
 - (2) Plot plan showing the proposed substation location and proposed access road.
 - (3) Grading plan of the proposed substation, access road, and adjacent areas.
 - (4) Soil report or suitable information for foundation design.
 - (5) The electrical rating of the ground fault limiting resistor, the resistor by-pass switch, current transformer, and any other associated equipment, if required by the applicant.
 - (6) Location, length, and description (overhead or underground) of the service connection to the applicant's facilities.
 - (7) Final disposition of yard drainage to determine if a special oil retention facility will be required.
 - (8) Landscaping plans, if required.
 - (9) Electrical plans, such as single-line, meter, and relay drawings, general arrangement of conduits and grounds, and elementary diagrams of the applicant's facility. These drawings shall include all high voltage fuse and/or breaker ratings, capabilities of interrupting devices, current transformer and potential transformer ratios and connections, and protective relay types, ranges, and settings.
 - B. Prior to operation:
 - (1) Documentation of permits the applicant has obtained for the substation and a written inspection clearance notice from the inspection authority having jurisdiction (city, county, or state agency, etc.).
 - (2) Signed reports for the following tests:
 - (a) Phase-to-phase and phase-to-ground megger test performed on the applicant's side of the open disconnect switch to the service point, including high voltage cable runs with all customer's primary breakers and fuses racked open.
 - (b) Individual megger tests on all major equipment, such as primary breakers, potential transformers, station service and auxiliary transformers.
 - (c) Ratio test of auxiliary transformers.
 - (3) Test report showing that the primary breaker relay settings conform with the protection requirements provided by PG&E.
22. The following data is to be furnished to the applicant by PG&E:
 - A. Substation equipment layout.
 - B. Arrangement and requirements for foundations, embedded stubs, and anchor bolts.
 - C. Arrangement of conduits, if required, and grounds.
 - D. Electrical data, such as short-circuit duty, transformer impedance, etc.
 - E. Outline of PG&E's transformer bank differential current transformers to be located in the applicant's switchgear, if required.

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- F. Engineering standards for substation fence and fence grounding.
- G. Requirements for revenue metering equipment.
- H. Space requirements and details of substation capacitors, if required.
- I. Provision for a mobile transformer, if required.
- J. Specification for an oil retention facility, if required.
- K. Relay coordination and other protection requirements.
- L. PG&E will prepare design drawing of the access road and fencing at the applicant's expense if the applicant so requests.

References

Document

General Notes for Grading and Paving for Substations	041838
Grounding Requirements for Outdoor Electrical Substations	067910
High Pressure Sodium Outdoor Lighting	459076
Method of Grounding Fences and Wire Trellises	020607
Property Fence and Gates	059659
Termination and Structure for 12 kV and 21 kV Underground Feeders Low Profile Substations	050861

Table 2 List of Material for Serving Single Customer Substations From Transmission Lines

Item	Description
	Material Furnished by PG&E
1	Structures ¹
2	Control Building
3	Transformer
4	Control Wiring
5	Lighting Fixture
6	Air Switch
7	High Voltage Fuses
8	Disconnect Switch
9	Station Service
10	Potential Transformer
	Material Furnished by Customer
11	Fence and Gates ²
12	Foundation
13	Grounding System
14	Conduits, ABS Type DB
15	Take-Off Equipment
16	Stubs and Anchor Bolts
17	Access Roads
18	Pothead and Support Structure

¹ Latticed steel or aluminum structures may be used instead of the tubular structures shown in Figure 1 on Page 5 and Figure 2 on Page 6.

² Gate location, roadway and inside substation arrangement may vary, depending on the direction of entry for the access road.

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60 or 70 kV Station for Overhead Service

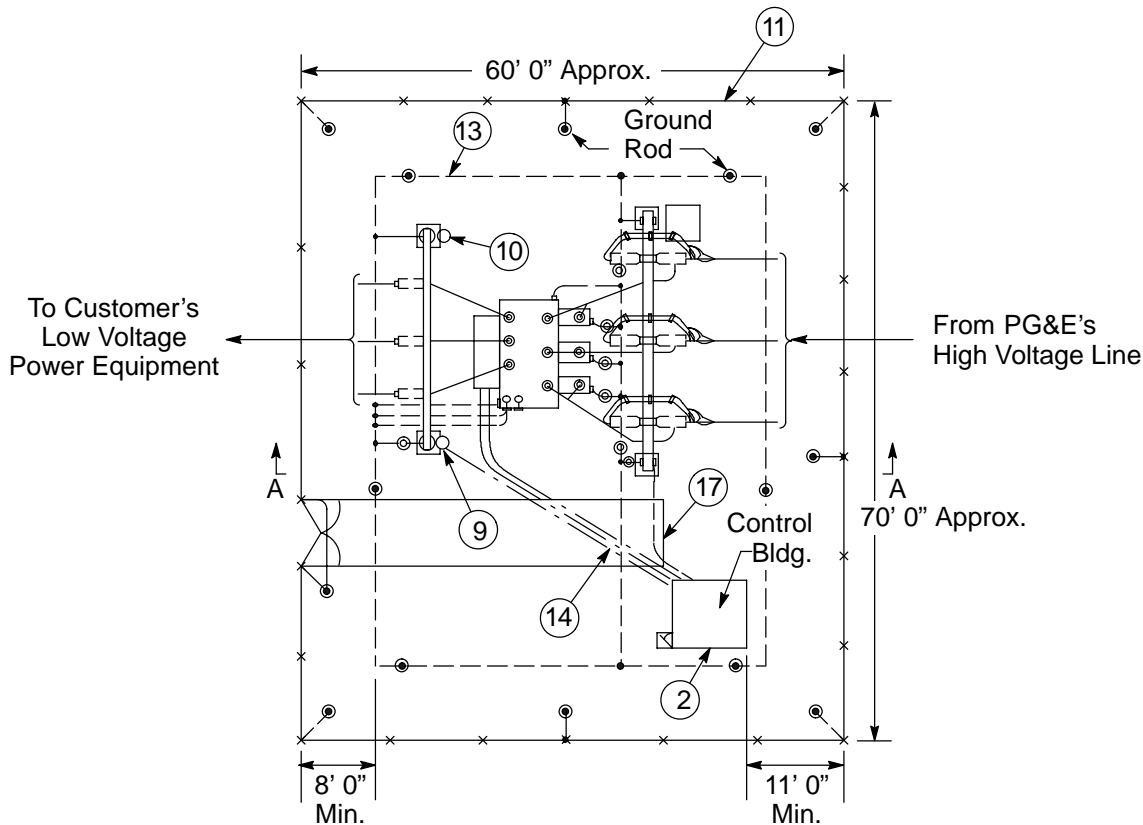
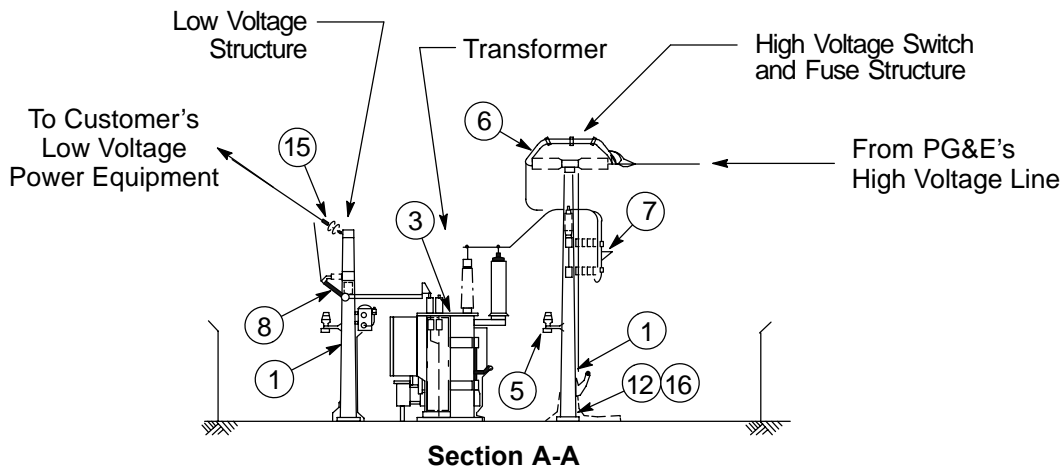


Figure 1
 Typical 60 or 70 kV Station for Overhead Service
 Plan View



Section A-A

115 kV Station for Underground Service

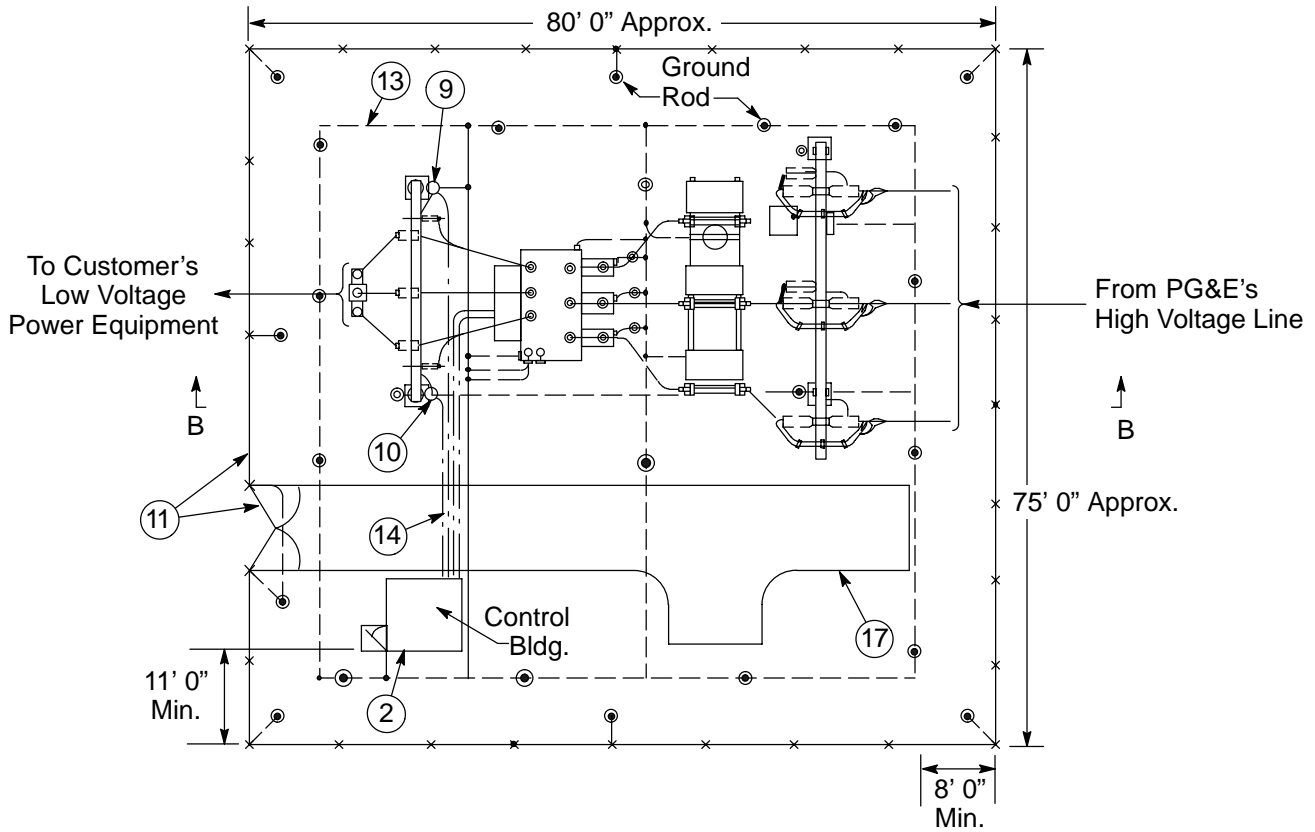
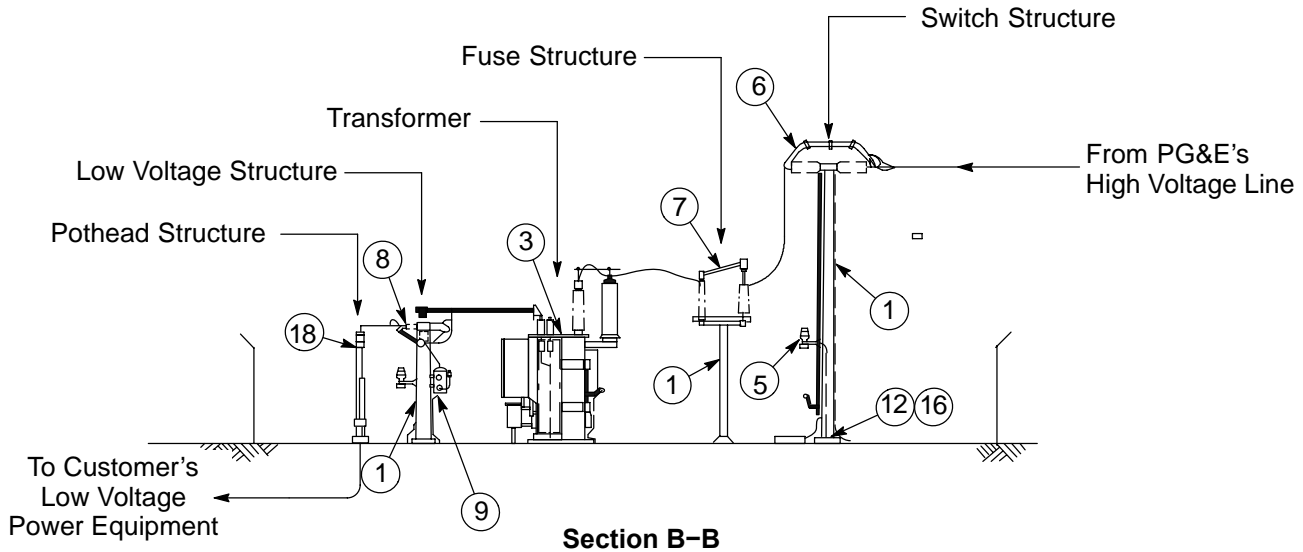


Figure 2
 Typical 115 kV Station for Underground Service
 Plan View



Section B-B

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Revision Notes

Revision 01 has the following changes:

1. Updated the "References" section on Page 4.