6B.5—Fence Application and Construction

1. Scope

This standard covers the construction requirements for permanent fencing around company substations or substation equipment. This standard shall also be used as an attachment to construction contracts for fence installation. The design considerations covered by this fencing application and construction standard are as follows:

1. Fence safety clearances
2. Curbed fence installations
3. Fence isolation sections
4. Removable fence section
5. Fence relocation
6. Cantilever gates

2. References

ANSI/IEEE C2, *National Electrical Safety Code (NESC)*

Company Substation and High-Voltage Equipment Engineering Handbook 6B.6, *Substation Grounding*

Company Construction Standard SG 001, *Substation High-Voltage Warning Signs*

PacifiCorp Standard Fence Drawings SR001, *Fence Plan & Details, Curbed*

PacifiCorp Standard Fence Drawings SR002, *Fence Plan & Details, Non-Curbed*

Company Standard Construction Specification 02810, *Chain Link Fencing and Gates*

Company Standard Construction Specification 02815, *Cantilever Slide Gate*

3. General

Fences are required to be installed around electrical equipment to minimize the possibility of entrance by unauthorized persons. This requirement includes platform mounted transformers and regulators that do not meet above ground equipment clearances.

3.1. Compliance with NESC

The construction of the fence must comply with NESC.

3.2. Grounding Requirements

Fences installed at electrical facilities typically must be grounded. All fence grounding shall be installed per 6B.6, *Substation Grounding*.

3.3. Locked Entrance

Entrances through fences not under observation of an authorized attendant shall be kept locked.

3.4. Isolation of Fences

Company substation fences shall not be connected to any other fence. See Subsection 5, *Fence Isolation Sections*, for additional information.

3.5. Clearances from Structures

The minimum distance that the fence should be installed from any substation structure supporting a live part shall be based on Section 7 of this standard. Any objects inside or outside the substation should not be located within a restricted zone. The minimum restricted zone shall be ±5 feet wide and 16 feet high; see Figure 3. If the minimum five (5) feet distance cannot be met, measures should be taken to prevent the likelihood of a person using the object to gain access to the substation. The restricted zone outside the substation fence may be used for the planting of screening vegetation, as long as it is not climbable by a person.

3.6. Curbing at Fence Line

Curbing at the fence line should be installed around new substations that are being constructed in higher security areas as determined by operations management. The purpose of the curbed fences is to prevent entrance under substation fences. Curbing at the fence line can also be installed to provide oil containment. Details for curbed fences are indicated in drawing SR001.

4. Fence Construction

The fence shall be constructed of chain link, unless noted otherwise, and shall be installed in strict compliance with furnished plans and these standards. Installation shall use good workmanship by skilled craftsmen, experienced in erection of this type of fencing. The fence shall be erected on the lines and to the grade as provided by the company. Unless project specific construction drawings and specifications are provided, the following documents shall be used for installation of the fence:

PacifiCorp Standard Fence Drawings SR001, *Fence Plan & Details, Curbed*

PacifiCorp Standard Fence Drawings SR002, *Fence Plan & Details, Non-Curbed*

Company Standard Construction Specification 02810, *Chain Link Fencing and Gates*

Company Standard Construction Specification 02815, *Cantilever Slide Gate*

These documents provide information on the fence materials, details of construction for the fences with and without curbs, typical swing gates and cantilevered gates, man gates and fence isolation sections. Unless indicated otherwise, the normal drive gate should be a 24-foot wide double swing gate.

4.1. Warning Signs

Warning signs shall be placed on all gates and on each straight fence run. Signs shall be placed on each fence run starting five (5) feet from the corner and at 65-foot maximum spacing. The “Warning! Hazardous Voltage Inside Keep Out” signs shall be placed five (5) feet above grade level as measured from the bottom of the sign. The “No Trespassing” sign should be placed at the same five foot level and immediately to the left or right of the warning sign. Approved signs are listed below:

- Warning! Hazardous Voltage Inside Keep Out (RMP):

  SI# 7999852

- Warning! Hazardous Voltage Inside Keep Out (PP):

  SI# 7999851

Mounting Hardware: SI# 7999092

The mounting hardware is comprised of aluminum brackets with one-inch tamper-proof bolts and locking nuts. The bolts are installed through the sign’s front, and screw into the aluminum brackets located on the interior of the fence. Four sets of mounting hardware are needed for each sign.

Drawings SR001 and SR002 indicate the placement locations for fence signs.

4.2. Inward-Opening Gate

In substations where there is limited property, such that the ground grid cannot be extended four (4) feet out from the gate swing radius, the gate shall be limited to opening inward only, with gate catches installed as shown in Figure 1. Gates so designated shall be equipped with 180° hinges to restrict gate opening.

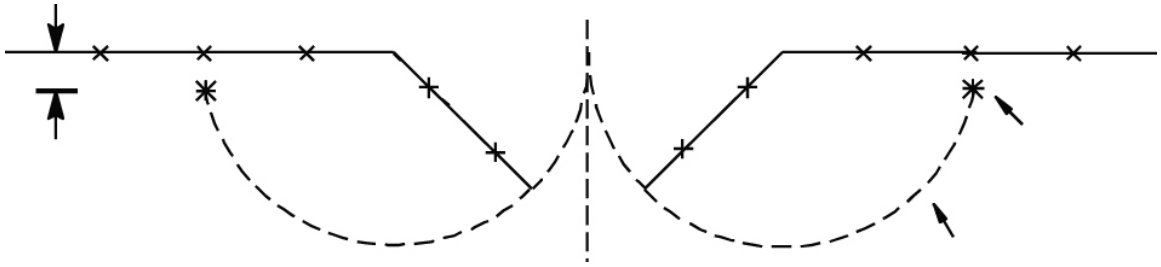

Figure 1—Inward Gate Swing

In substations where the ground grid has been extended outside the gate swing radius, gate catches shall be installed as shown in Figure 2.

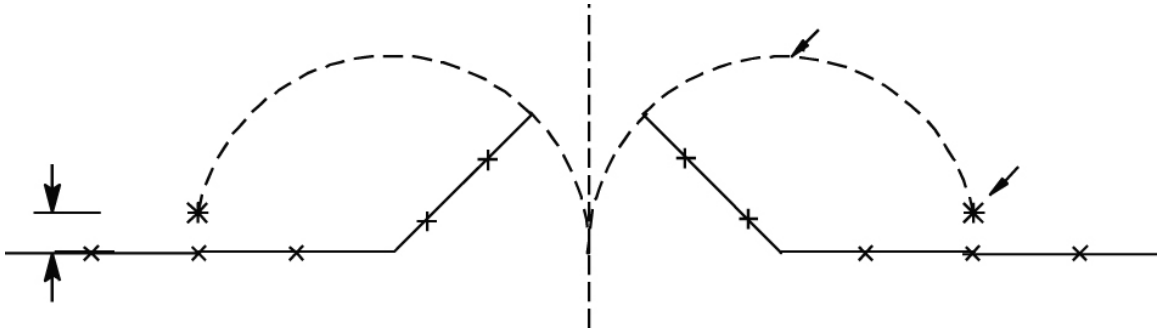

Figure 2—Outward Gate Swing

5. Fence Isolation Sections

When a company substation fence is to be adjacent to any other fence, an intermediate section of fence must isolate the two sections of fences. Details for construction of fence isolation panels are indicated in Drawings SR001 and SR002 for curbed and non-curbed fences respectively.

6. Removable Fence Section

A removable fence section may be required in substations with limited property to facilitate the removal of station equipment. Where feasible, a gate should be installed instead of a removal fence section. When a gate cannot be provided, the civil engineering department should be contacted for a custom designed removable fence section.

7. Fence Safety Clearances

Safety and operating clearance zones that are illustrated in Table 1 and Table 2 respectively shall be maintained when designing the substation fence location. These safety zones are designed to prevent contact with live parts by a person inserting an object through the substation fence. The fence should be located such that all live parts are outside the safety zone. The operating clearance zone is designed to allow adequate space between the fence and equipment for operation

and maintenance purposes. The more stringent of the two requirements shall govern when designing the fence location. See Figure 3 for an example of a 12.5 kV substation.

Table 1—Fence Safety Clearances (Dimensions for use with Figure 3)

Nominal Voltage (Between Phases)	Dimensions "A" (Vertical)		Dimension "B" (Horizontal)	
(volts)	(feet)	(meters)	(feet)	(meters)
151–34500	15.0	4.6	11.0	3.4
46000– 69000	16.0	4.9	12.0	3.7
115000	17.0	5.2	13.0	4.0
138000	17.0	5.2	14.0	4.3
161000	18.0	5.5	15.0	4.6
230000	19.0	5.8	16.0	4.9
345000	21.0	6.4	20.0	6.1
500000	25.0	7.6	23.0	7.0

Table 2—Fence Operating Clearances (Dimensions for use with Figure 3)

Equipment Type	Dimension "B" (Horizontal)
Fuse Structure of Disconnect Switches	20 feet
Operation Handles of Airbreak Switches	15 feet
Structures where there is no equipment	10 feet

Notes:

1. Dimension A is equal to the vertical clearance of wires, conductors, and cables above spaces and ways subject to pedestrians or restricted traffic only (ANSI C2 [1], rules 232A and 232B, and table 232−1, 5) for the voltage considered. All vertical clearances are rounded up.
2. The B dimension is the horizontal clearance to unguarded live parts in electric-supply stations (ANSI C2(1), Rule 110A.2 and table 110-1). The clearance dimensions are rounded up and increased for 345 and 500 kV voltages to match the recommended values used in the company Engineering Handbook Section 6B.10, *Minimum Clearances for Substation Electrical Conductors*.
3. The values shown for dimension A for nominal voltages between phases of 115 kV and above should be increased 3% for each 1000 feet (300 m.) elevation in excess of 3300 feet (1000 m.) above mean sea level.

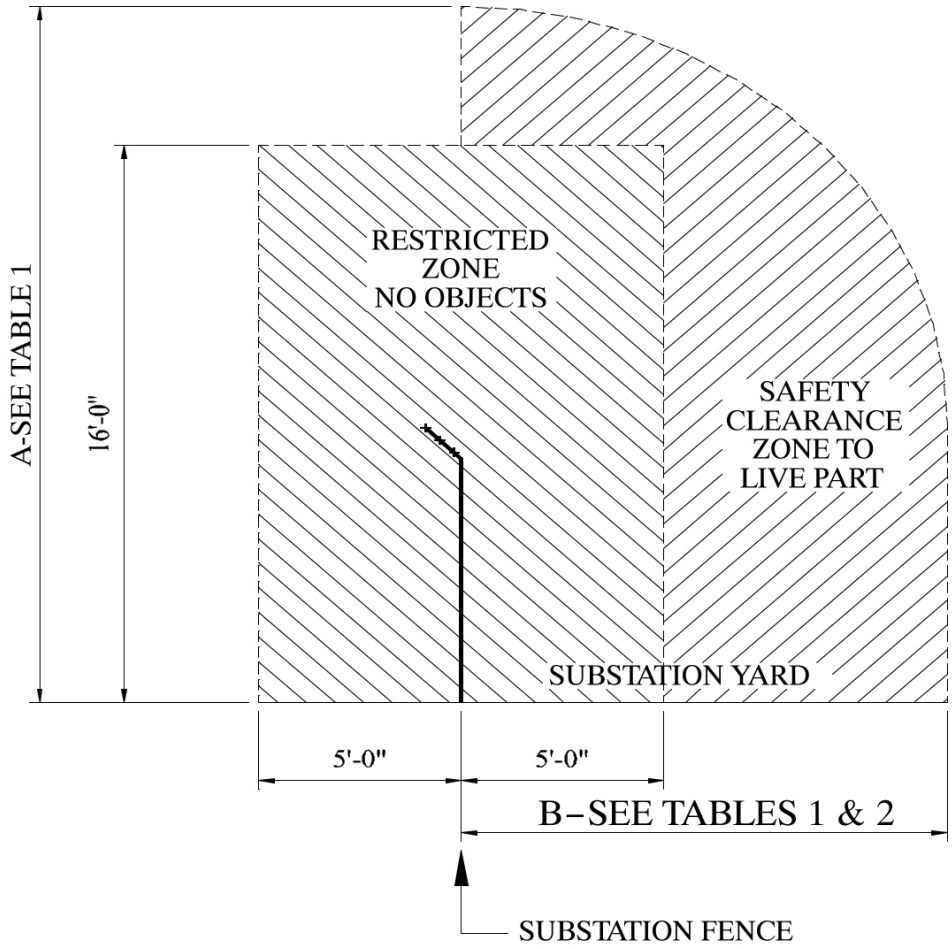

Figure 3—Safety Clearance for Substation Fence

8. Fence Relocation

8.1. Expansion of Substations

When specified in the contract documents, portions of an existing fence shall be removed and relocated (only if existing fence fabric and overall height meets current 8'- 0" height requirements), in accordance with these specifications and drawings furnished. The following fence materials may be reused if in good condition: Fabric, brace, rail and top rail, stretcher bars, truss rods, truss bands, security wire, gate frames and gate hardware. Reused fence materials shall be removed and handled with care so as not to damage them. New bottom tension wire and hog ties must be installed, and fence posts shall not be reused. All fence materials which are not reinstalled shall be returned to the nearest company warehouse unless stated differently in the contract.

When relocating an existing fence, the contractor shall coordinate the work so that security is maintained at all times.

Fence signs installed must be compliant with this standard.

8.2. New Fence to Existing Fence

When enlarging a substation by installing a new fence to an existing substation, the new fence shall meet the current fence height standard of eight (8) feet zero (0) inches (including barb wire). Details for joining unequal height fences are indicated in drawings SR001 and SR002.

9. Cantilever Gates

Cantilever gates may be required in substations with limited property to facilitate the removal of station equipment, or to accommodate a wider gate for mobiles and large equipment. If a cantilever gate is deemed necessary, the civil engineering department shall be consulted.

10. Handbook Issuing Department

The engineering standards and technical services department of the company published this document. Questions regarding editing, revision history, and document output may be directed to the lead editor at eampub@pacificorp.com. Technical questions and comments may be directed to Iuda Morar (503) 813-6937 or Perumal Radhakrishnan, (503) 813-5699, substation standards engineering. This handbook document shall be used and duplicated only in support of company projects.