



## **The Interconnection Handbook**

### **Southern California Edison Company**



<b><i>Transmission &amp; Distribution Business Unit, Transmission &amp; Interconnection Planning</i></b>	<b>NERC Reliability Compliance Program</b>	Document No.	1
		Version No.	5
<b>INTERCONNECTION HANDBOOK</b>		Effective Date	10/5/11

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## Section 1: Summary of Technical Requirements

### 1.1 Introduction

#### 1.1.1 Minimum Requirements

Southern California Edison Company's (SCE) Interconnection Technical Requirements (Requirements) specify the typical minimum technical requirements to interconnect facilities with SCE's electric system. These requirements are necessary to ensure safe and reliable operation of SCE's electric system.

#### *Applicable to Generation Facilities*

Throughout the Requirements, the owner, its agents, or the operator of only a generation facility to be interconnected with SCE that includes performing the functions of supplying energy and a service (exclusive of basic energy and transmission services) to support the reliable operation of the transmission system shall be referred to as the “Producer.”

These Requirements apply to the following types of interconnections of generating facilities to SCE's electric grid:

- a) New generation interconnections (i.e., those interconnections not currently or previously connected to SCE's electric system).
- b) Material changes to existing generating facilities including, but not limited to, changes in plant generating capacity, changes in plant load, and/or modifications to related equipment.
- c) Existing generating facilities entering the energy market for the first time. This would include existing Qualifying Facilities converting to a CREST, WDAT, or Transmission Owner Project.

#### *Applicable to Transmission Facilities*

Throughout the Requirements, facilities that include interconnection of a group of lines and associated equipment for the movement or transfer of electric energy between points of supply and points at which it is transformed for delivery to customers or is delivered to other electric systems shall be referred to as “Transmission Facilities.”

#### *Applicable to End-User Facilities*

Throughout the Requirements, an interconnection that includes retail service, export-for-sale service, load (dynamic and static), and reactive devices (capacitors and reactors), shall be referred to as “End-User Facilities.”

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***Applicable to Generation, Transmission, and End-User Facilities***

Throughout the Requirements, if an entry is applicable to all facilities, such as generation, transmission, and end-user facilities, the requirements will address each type of facility interconnection as one entity referred to as “Interconnected Facility (INTFAC).”

The Requirements do not, and cannot, address all the technical requirements applicable to a specific facility interconnection. Each interconnection is unique. Once sufficient facility information is provided by the INTFAC, SCE will determine and communicate the additional project-specific technical requirements to the INTFAC. INTFACs should discuss their project plans with SCE before purchasing or installing equipment or making other major financial commitments. SCE will follow notification procedures for new or modified facilities in the Transmission Control Agreement (TCA) per Section 4.2.3, with respect to the California Independent System Operator (CAISO) Register. In addition, INTFACs may inquire about procedures for notification of new or modified generation, transmission, and end-user facilities from the following contact:

Contact	Mailing Address
Manager, Grid Interconnection & Contract Development	P.O. Box 800 2244 Walnut Grove Avenue Rosemead, California 91770

Nothing contained in this document is intended to modify the parties' rights and obligations under SCE or CAISO tariffs, or interconnection agreements with the INTFAC. The provisions of those tariffs and agreements supersede any provisions contained in this document that may appear to be inconsistent or contrary.

**1.1.2 Purpose of Interconnection Handbook**

***Applicable to Generation, Transmission, and End-User Facilities***

This document has been prepared to identify the technical requirements for connecting new facilities to the SCE transmission system. This document provides an overview of the technical and reliability requirements to address interconnection requests. The interconnections include facility additions and modifications to accommodate generation, transmission, and end-user facilities that are being connected to or planned to be connected to the SCE transmission system. This document is written to support compliance with [NERC Standards, FAC-001 Facility Connection Requirements](#), which requires entities responsible for the reliability of the interconnected transmission systems to maintain and publish a Facility Connections Requirements document. The North American Electric Reliability Corporation (NERC)

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standards require those entities seeking to add facilities or connect to the interconnected transmission system to comply with the Facility Connection Requirements document. This document is not intended to be used as a design specification. SCE's Requirements are intended to provide a simple-to-use source for determining the minimum technical requirements necessary to interconnect a facility with SCE's electrical system. Although interconnections may be technically complex, it is SCE's intent to make the interconnection process as straightforward as possible.

In support of this intent, SCE is providing INTFACs with general technical information needed to properly interconnect facilities with the SCE grid, and provides descriptive examples of the electrical equipment they may need for their interconnection. This document does not address procedural information related to facility interconnections, nor cover all possible technical details. Other requirements and documents such as interconnection contracts, rules, tariffs, and additional reliability criteria, provide additional information to the INTFAC. The final design of facility connections to the SCE transmission system will be subject to SCE review and approval on a case-by-case basis.

This document also provides a means to facilitate communication of technical information to SCE regarding the INTFAC.

SCE's Requirements do not cover all aspects of applicable technical criteria that may apply to an INTFAC's project. The INTFAC is responsible for familiarity and compliance with all standards and criteria applicable to its specific project. A listing of technical standards and criteria referenced in these Requirements is provided for information as Appendix A.

These Requirements do not address the administrative or commercial requirements for INTFACs to SCE owned transmission or distribution systems.

### **1.1.3 Conformity**

#### ***Applicable to Generation, Transmission, and End-User Facilities***

The INTFAC shall comply with all applicable reliability standards for its facilities. SCE will not assume any responsibility for complying with mandatory reliability standards for such facilities and offers no opinion whether the Interconnection Customer must register with NERC pursuant to Section 215 of the Federal Power Act. If required to register with NERC, the INTFAC shall be responsible for complying with all applicable reliability standards for its facilities up to the Point of Change of Ownership as described in Appendix A of each project's interconnection agreement.

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The INTFAC is responsible for conforming to applicable:

- Federal Energy Regulatory Commission (FERC) Rules, Regulations, and Orders
- North American Electric Reliability Corporation (NERC) Standards
- Western Electricity Coordinating Council (WECC) Regional Criteria, Policies, and Guidelines
- California Independent System Operator (CAISO) Planning Standards
- SCE Reliability Criteria, as well as good engineering and utility practice.

#### **1.1.4 Requirements are Subject to Change**

##### ***Applicable to Generation, Transmission, and End-User Facilities***

These Requirements are subject to change. INTFACs have the responsibility to ensure that they comply with the most recent version of the Interconnection Requirements. The current version may be accessed at SCE's internet site:

<http://www.sce.com/AboutSCE/Regulatory/openaccess/>

Each page of SCE's Interconnection Handbook displays its effective date in the lower left hand corner.

#### **1.1.5 Applicability**

##### ***Applicable to Generation, Transmission, and End-User Facilities***

Nothing in this document is intended to supersede Interconnection Agreements agreed to by SCE and the INTFAC, and, if there is a conflict, the Interconnection Agreement, as applicable, will control.

Upon execution of an Interconnection Agreement per the appropriate tariff, the INTFAC should make reference to this document in its entirety during the construction process.

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## **Section 2: Parallel Systems**

### ***Applicable to Generation Facilities***

These Requirements apply to interconnecting generating facilities that intend to operate in parallel with SCE's system, and ultimately deliver power to the CAISO grid (directly to the transmission system, or via SCE's Distribution system).

Subject to FERC, California Public Utilities Commission (CPUC) regulations, and SCE approval, an INTFAC may elect to operate a generating facility in parallel with SCE or as a separate system with the capability of non-parallel load transfer between the two independent electrical systems. Induction generators, and some systems using inverter devices, must be operated in parallel to produce energy. Synchronous generators may be operated either in parallel or as a separate system. However, please note that the Requirements provided in this document are applicable to interconnecting generators intending to operate in parallel.

## **2.1 Parallel Operation**

### **2.1.1 Definition**

#### ***Applicable to Generation Facilities***

A parallel system is one in which the Producer's generating facilities can be operated while connected to SCE's system. A consequence of such parallel operation is that the parallel generator becomes a part of SCE's electrical system, and must, therefore, be considered in planning the protection of SCE's system.

### **2.1.2 Need for Protective Devices**

#### ***Applicable to Generation Facilities***

Prudent electrical practices require that certain protective devices (relays, circuit breakers, etc.) specified by SCE must be installed at any location where a Producer desires to operate its generating facilities in parallel with the SCE system. The purpose of these devices is to promptly disconnect the Producer's generating equipment from the SCE system when faults or abnormal operation jeopardize the reliable operation of equipment or the safety of personnel. Other modifications to electrical system configuration or protective relays may also be required in order to accommodate parallel generation. SCE assumes no responsibility for determining protective equipment needed to protect Producer's facilities.

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### **2.1.3 Hazards**

#### ***Applicable to Generation Facilities***

SCE's transmission and distribution lines are subject to a variety of natural and man-made hazards. Among these are lightning, earthquakes, wind, animals, automobiles, mischief, and human error. Producer's electric systems are subject to these same hazards but not nearly to the same degree because SCE's system has greater exposure to these hazards.

The electric problems that can result from these hazards are principally short circuits, grounded conductors, and broken conductors. These fault conditions require that damaged equipment be de-energized as soon as possible to ensure public safety and continued operation of the remainder of SCE's system.

Where SCE controls the only source of supply to a given transmission or distribution line, it has the sole responsibility to install protective equipment to detect faulted equipment or other operating abnormalities and to isolate the problem from the remainder of SCE's electrical system. A non-SCE generating facility connected to and operated in parallel with an SCE line represents another source of power to energize the line. Accordingly, SCE requires that such facilities also have adequate protective devices installed to react to abnormal electric system conditions and isolate from SCE's electric system.

### **2.1.4 Islanding**

#### ***Applicable to Generation Facilities***

Generating facilities operating in parallel with SCE's electric system must also be equipped to detect another condition referred to as "islanding." Islanding is the abnormal operating condition where a portion of SCE's electric system and loads become isolated from the remainder of SCE's electric system while still connected to and receiving energy from generating facilities within an electrical island. When islanding occurs, all generating facilities within the electrical island must be disconnected to prevent continued operation.

The protective devices and other Requirements established by SCE in Section 3 are intended to provide protection against hazards, such as those noted above, by ensuring that parallel generating facilities are disconnected when abnormal operating conditions occur. The following sections reflect the fact that these Requirements are typically minimal for small installations, but increase in scope and/or complexity as the size of the generation installation increases. SCE may require voltage and frequency protective functions or relays to detect islanding and shut down generation during periods of islanding.

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## 2.1.5 UPS

### *Applicable to Generation Facilities*

Uninterruptible Power Supply (UPS) systems will be classified as either a separate or a parallel system depending on the following criteria. If such UPS systems are not capable of transfer of electric power from the emergency source to SCE's electric system, they will be classified as a separate system generating facility. If such UPS systems are capable of transfer of power, they must meet the Requirements for parallel generation.

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## Section 3: Protection Requirements

### *Applicable to Generation, Transmission, and End-User Facilities*

Protective devices (relays, circuit breakers, synchronizing equipment, etc.) must be installed for the protection of SCE's system as required by SCE. Generally, the protective devices may differ with the relative electrical capacity of the installation. The larger the installation, the greater the effect it may have on SCE's electrical system. For instance, a manual disconnecting device must be provided by the INTFAC, but the form of this device will vary with the service voltage and generating facility capacity. For voltage classes 200 kV and above, primary relay protection for network transmission circuits will be designed to clear transmission line faults within a maximum of 6 cycles. Project stability studies may indicate that faster clearing times are necessary.

To ensure the reliability of the electric system, protective relays, and associated equipment require periodic replacement. Typically the frequency of transmission line relay replacement does not exceed once every fifteen (15) years, but equipment failure, availability of replacement parts, system changes, or other factors may alter the relay system replacement schedule.

**Categories:** SCE's Requirements identify three different categories for Producer generating facilities connecting to the SCE system each with distinctive protection Requirements. These categories are:

1. Interconnection voltage above 34.5 kV
2. 200 kVA and above capacity, interconnection voltage 34.5 kV or below
3. Less than 200 kVA capacity, interconnection voltage 34.5 kV or below

**Aggregation:** Where multiple generating facilities (with a single owner) are allowed to connect to SCE's system through a single point of interconnection, the interconnection is said to have aggregated generating facilities. The appropriate category of aggregated generating facilities is calculated by summing the KVA ratings of the multiple generators.

**Disclaimer:** The categories above have been established for convenience and are based on urban/suburban circuits with normal load density. The final decision as to the specific requirements for each installation will be made by SCE depending on several factors that could include Producer load magnitude, the magnitude of other load connected to that circuit/system, available short circuit duty contribution, and other conditions SCE deems prudent.

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The Protection Requirements of the above three categories are described in Sections 3.1 to 3.3. These sections include Figures 3a through 3h to illustrate typical installations of protection equipment. The following is a legend of device numbers referred to in these figures:

**Legend**

**Protective Device Numbers and Description**

4	Master Contactor
25	Synchronizing or Synchronism Check
27	Under-voltage
32	Power Direction
40	Loss of Field Detection
46	Current Balance
47	Voltage Phase Sequence
51	Time Over-current
51G	Ground Time Over-current
51N	Neutral Time Over-current
51V	Voltage Restrained/Controlled Time Over-current
59	Over-voltage
59G	Over-voltage Type Ground Detector
67V	Voltage Restrained/Controlled Directional Time Over-current
78	Loss of Synchronism (Out-of-Step)
79	Reclosing Relay
810	Over-frequency
81U	Under-frequency
87	Current Differential

NOTE: For additional information on device numbers, refer to ANSI C37.2.

### **3.1 Category 1: Voltage Over 34.5 kV**

#### ***Applicable to Generation Facilities***

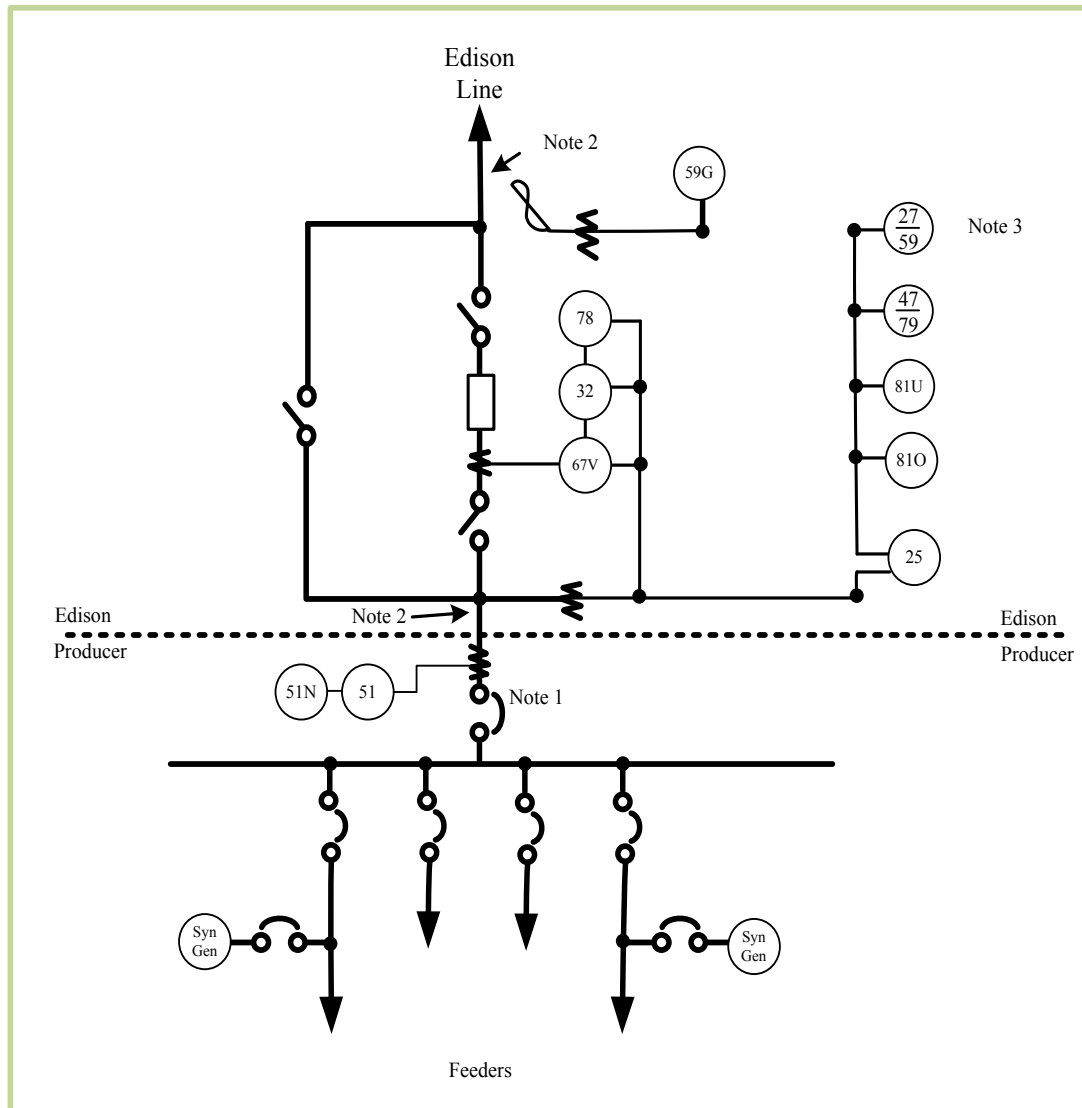
This Category is limited to generating facilities interconnecting at a single point with interconnection voltage above 34.5 kV. This requirement applies to all interconnections to the CAISO controlled grid, and to interconnections to SCE owned and operated facilities above 34.5 kV.

### 3.1.1 Typical Installations

#### *Applicable to Generation Facilities*

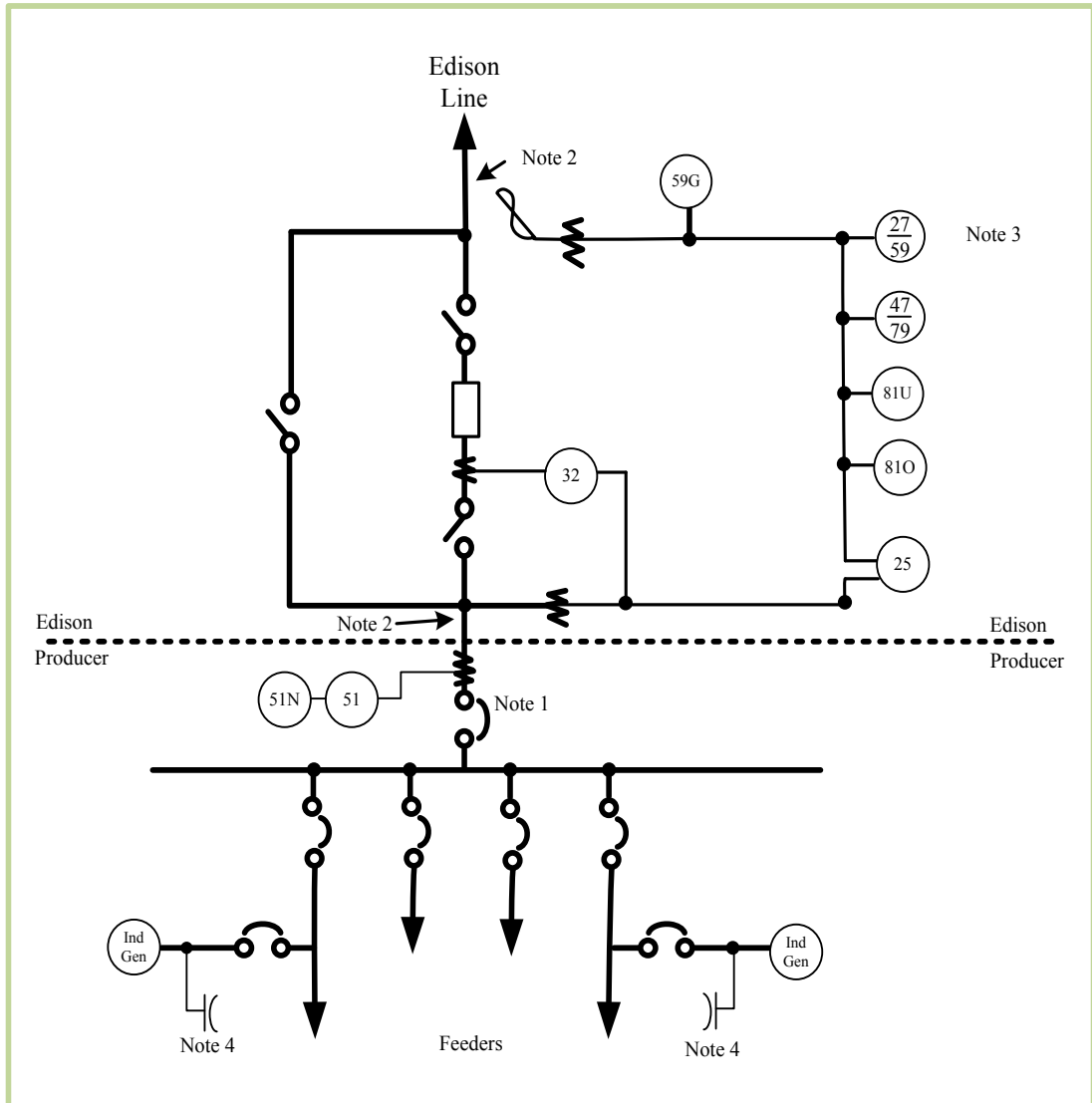
Figures 3a and 3b show typical installations with the SCE interface.

**Figure 3a: Typical Synchronous Parallel Generation with Assumed SCE Owned Protection (> 34.5 kV)**



- Notes:
1. Producer's main breaker or switch.
  2. Transformation, if required, may be by SCE or the Producer.
  3. Relay operates on two different phase-to-phase voltages.
- Not all Producer-side protective relaying is shown.**

**Figure 3b: Typical Induction Parallel Generation with Assumed SCE Owned Protection (>34.5 kV)**



- Notes:
1. Producer's main breaker or switch.
  2. Transformation, if required, may be by SCE or the Producer.
  3. Relay operates on two different phase-to-phase voltages.
  4. See Section 5.8.

**Not all Producer-side protective relaying is shown.**

For induction generation interconnection facilities, the Producer is responsible for installing the appropriate VAR supporting equipment at its facility to maintain unity power factor at the point of interconnection.

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### **3.1.2 Specific Requirements for Category 1**

#### *Applicable to Generation Facilities*

- a) Typically SCE-owned and controlled circuit breaker to disconnect generating facilities during SCE system trouble.
- b) Producer-owned and controlled circuit breaker or disconnect switch (as required – refer to Section 5.11 Switching and Tagging Rules) at the main to disconnect for Producer system trouble. If desired, SCE may permit the Producer to trip and/or close the SCE breaker by remote control. If synchronizing is to be done with SCE, SCE will install synchronizing supervision relays and telecommunications as required.
- c) Producer to provide synchronizing relays or equipment at the main, generator, and other breakers as appropriate. Either induction starting, automatic synchronizing, or manual synchronizing supervised by a synchronizing relay must be provided by the Producer.
- d) Induction starting will be permitted only where the inrush will not exceed SCE prescribed limits. Producer shall never attempt to parallel its system with SCE's system when the Producer's synchronizing facilities are malfunctioning or inoperative. Manual synchronizing without a supervising relay is not permitted. Automatic synchronizing may be required for synchronous generators which contribute short circuit current exceeding 5 (%) percent of the pre-existing short circuit current at the point of interconnection with SCE's distribution system.
- e) Protection related telecommunications may be required as determined by SCE Protection Engineering.

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### 3.1.3 SCE-owned and maintained protective relays which perform the following functions

#### *Applicable to Generation Facilities*

a) **Short Circuit Protection** (Devices 51V or 67V, 51N or 59G)

The designated relays will detect faults on the SCE electric system to which the Producer's generating facility is connected. Generally, the phase relays are voltage restrained overcurrent type or impedance torque controlled overcurrent type. Occasionally, pilot relays or transferred tripping relays may be required. In ground fault protection, a directional overcurrent relay or ground fault voltage detector may be used. A grounding transformer may be required to avoid dangerous overvoltages which could occur during accidental isolation of the line from the main system while the generator is in operation. Adequate grounding can be provided either by the use of a wye-grounded-delta main power transformer or by installing an appropriate grounding transformer. To limit the effects of such grounding on SCE's ground relay sensitivity, SCE may require that the grounding impedance be limited to the highest value suitable for neutral stabilization. Devices 51V or 67V are normally omitted for induction generator installations because of the absence of sustained fault currents from these generators.

b) **Islanding Protection** (Devices 27/59, 81-0, 81-U)

During the course of fault clearing or due to accident, equipment malfunction, or malicious mischief, it is possible for an SCE circuit/system to become separated from the main system, leaving customers on the circuit supplied from the Producer's generator. In order to protect customers from abnormal voltage or frequency excursions under these conditions, and to facilitate rapid restoration of normal service, relays for islanding protection are required. Generally, these relays will provide over and under frequency functions and three phase over- and under-voltage functions with instantaneous overvoltage tripping. For generating facilities aggregating 10 MW and greater, SCE may elect to use a voltage phase comparison system (Telesync) for islanding protection while retaining the voltage and frequency relays for backup.

c) **Breaker Closing/Reclosing Control** (Devices 25, 47, 79)

It is important that the closing of the SCE circuit breaker be controlled so that it can only be closed when it is safe to do so. Inadvertent closing of the circuit breaker could result in paralleling out of synchronism or energizing of de-energized facilities, and hazardous conditions could result. The required logic for manual closing of the SCE breaker is:

- 
- The line side of the breaker is energized with proper voltage and phase sequence, the load side of the breaker is de-energized and the Producer's main breaker (or generator breaker) is open, or
  - Synchronism check across the breaker is satisfactory which, in most cases, indicates that either the breaker bypass switch is closed or interconnection with the Producer already exists elsewhere.

In order to provide the best continuity of service to the Producer, automatic reclosing of the SCE breaker subsequent to fault clearing is engineered into the control circuitry. If the trouble is permanent, the breaker will trip again and lockout. No further reclosing will take place until the breaker has been reclosed manually. The required conditions for automatic reclosing are the same as for manual closing. Where provision is made for closing of the SCE circuit breaker by the Producer, the required conditions for closing will be the same as for manual closing by SCE. The Producer's closing control will enable SCE's synchronizing relay to close the breaker.

d) **Loss of Synchronism** (Device 78)

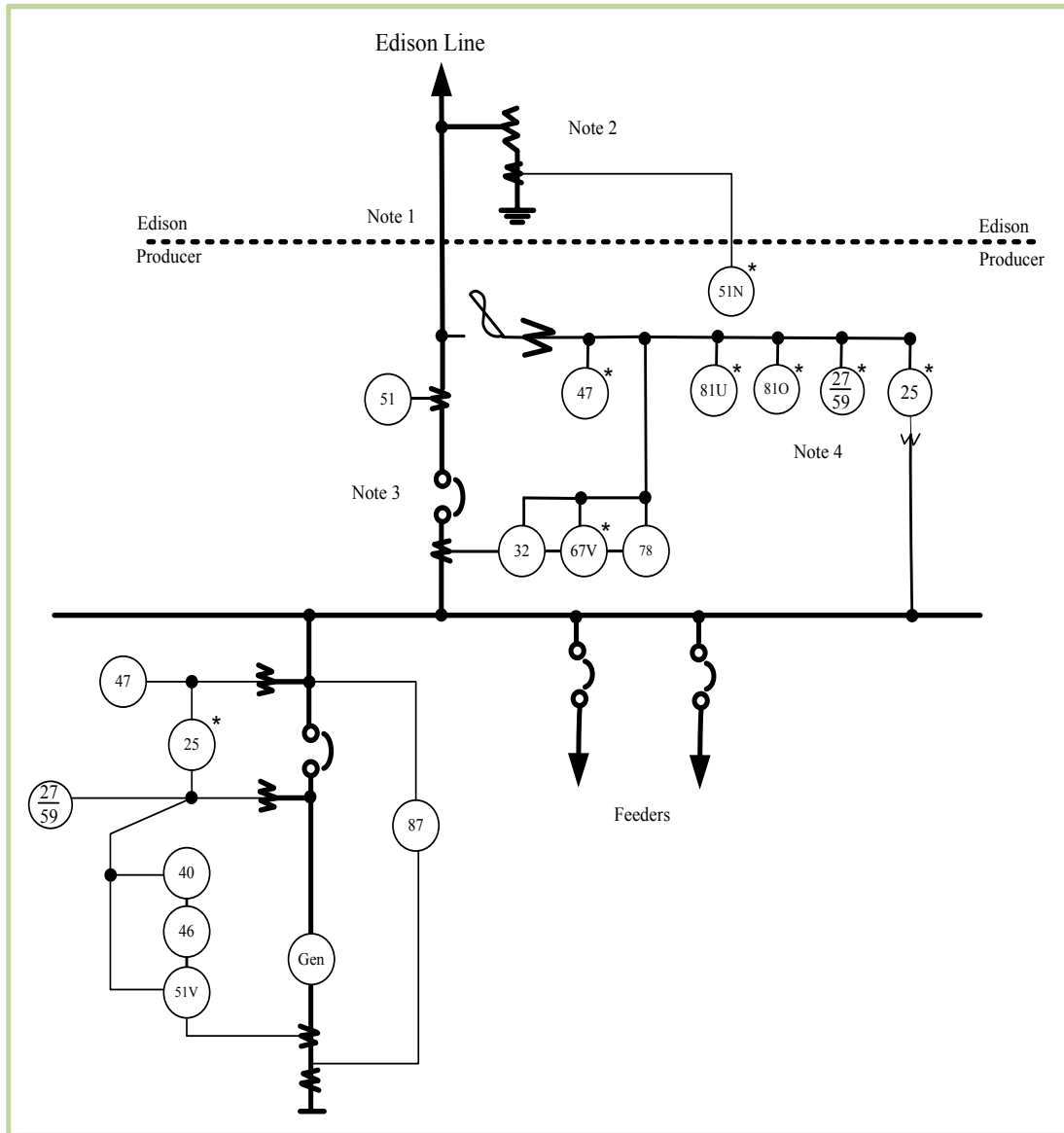
Operation of the Producer's synchronous generator out of synchronism with SCE may cause large voltage fluctuations to SCE's customers and may cause severe damage to the generator. If SCE determines that the relative capacities of its system and of the Producer's generating facility are such that this situation is likely to occur or for those installations which have experienced such voltage fluctuations, specific relays for detection of loss-of-synchronism (out-of-step) will be required.

### **3.2 Category 2: Total Generation 200 kVA and Above, Voltage at 34.5 kV or Below**

#### ***Applicable to Generation Facilities***

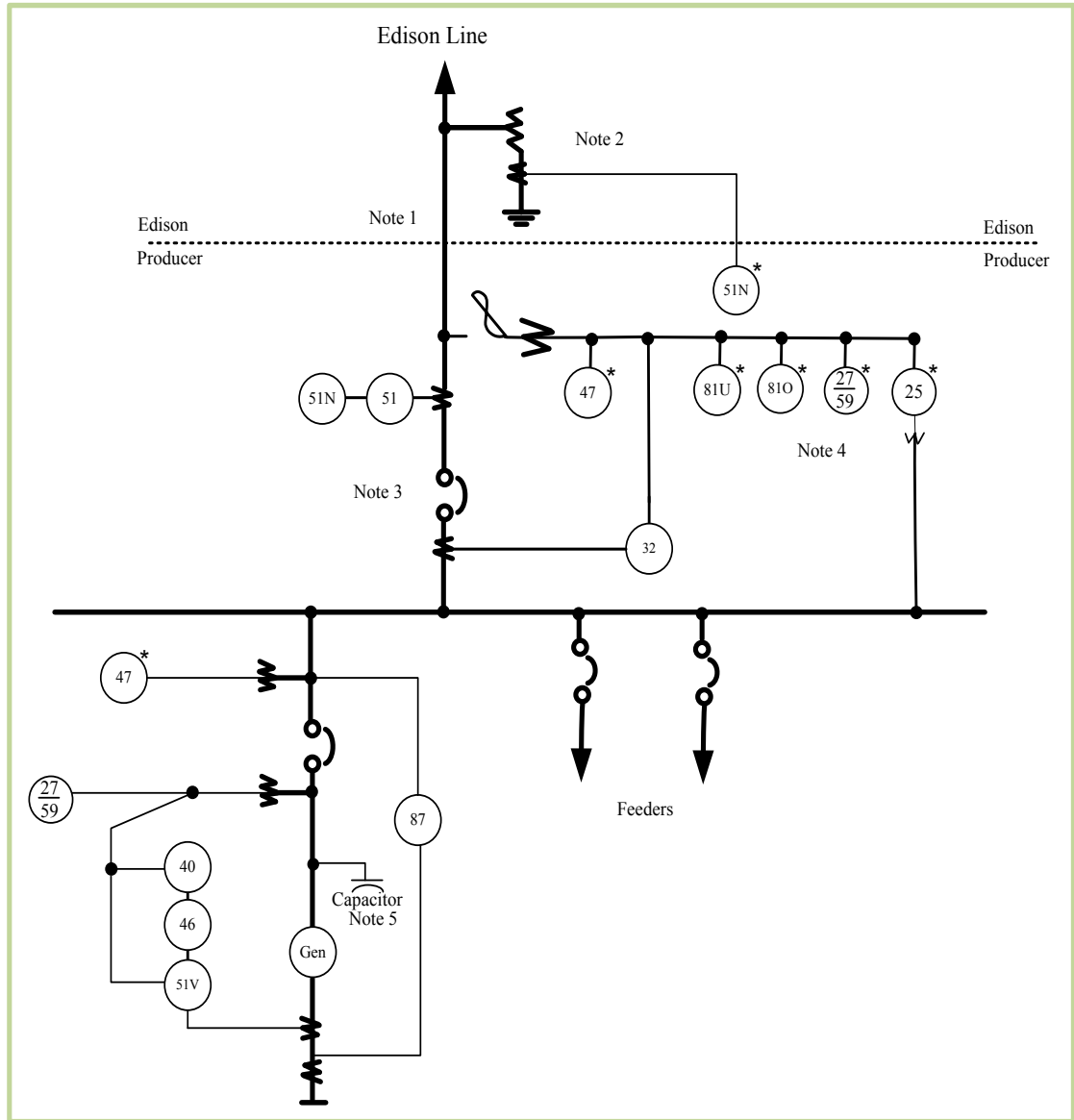
All installations in this Category require SCE review of the protective functions to be provided by the Producer. Refer to Figures 3c and 3e for typical installations. Producers must ensure their compliance to SCE's telemetering Requirements as stated in Section 7 of these Requirements.

**Figure 3c: Typical Synchronous Parallel Generation with Assumed Producer Owned Protection (> 200 kVA, < 34.5 kV)**



- Notes:
1. Transformation (as required) by SCE or the Producer.
  2. Grounding transformer or ground detector is required to be supplied by SCE unless the main transformer is wye grounded/delta. (See 3.2.3.d for requirements)
  3. Protective and synchronizing relays required if the Producer desires to serve isolated load during SCE outage. If not provided at main circuit breaker, these functions should be provided at generator breaker.
  4. Two phase-to-phase connected or three phase-to-neutral connected relays required.
- "\*" Indicates devices required by SCE. Others are shown as conventional practice.

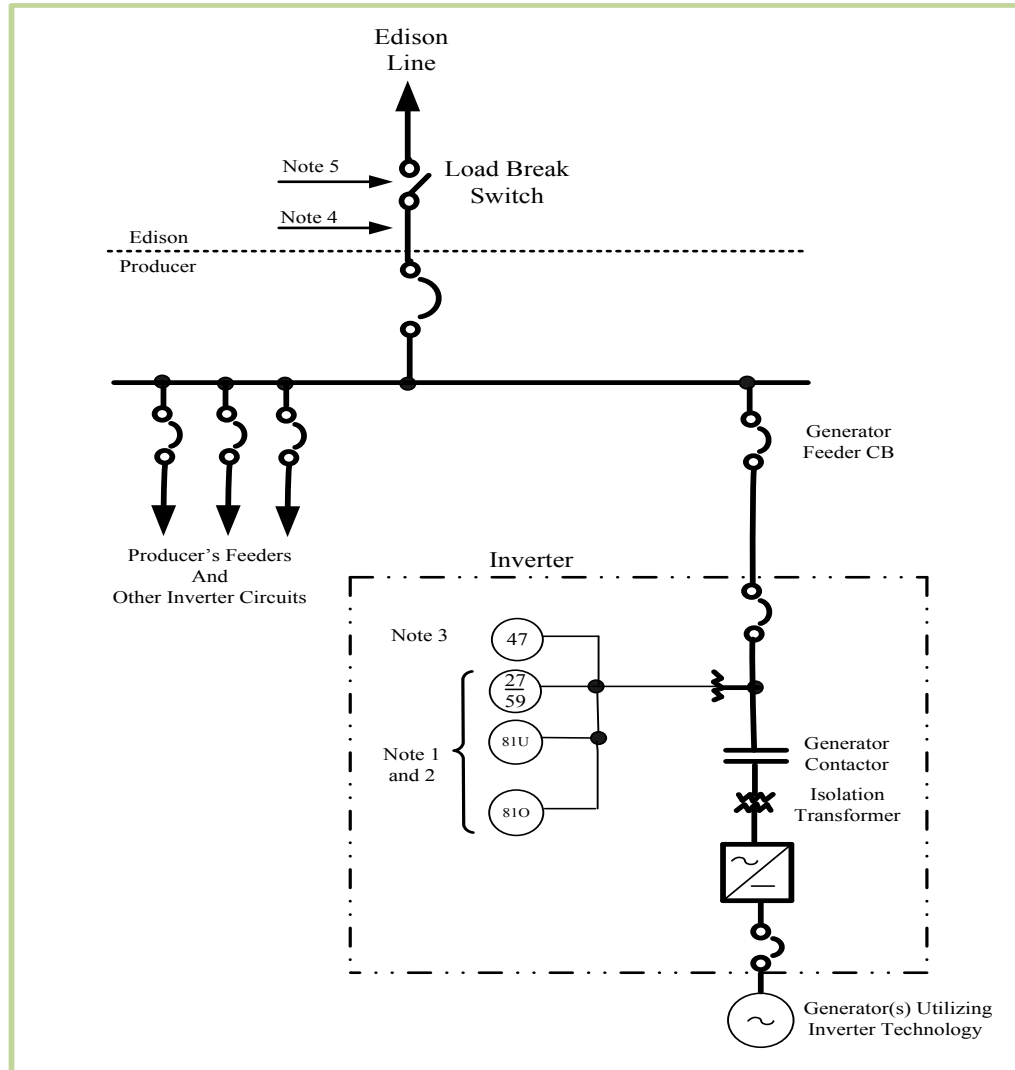
**Figure 3d: Typical Induction Parallel Generation with Assumed Producer Owned Protection (> 200 kVA, < 34.5 kV)**



- Notes:
1. Transformation (as required) by SCE or the Producer.
  2. Grounding transformer or ground detector is required to be supplied by SCE unless the main transformer is wye grounded/delta. (See 3.2.3.d for requirements)
  3. Protective and synchronizing relays required if the Producer desires to serve isolated load during SCE outage. If not provided at main circuit breaker, these functions should be provided at generator breaker.
  4. Two phase-to-phase connected or three phase-to-neutral connected relays required.
  5. Refer to Section 5.7.
- \*\*\* Indicates devices required by SCE. Others are shown as conventional practice.

For induction generation interconnection facilities, the Producer is responsible for installing the appropriate VAR supporting equipment at its facility to maintain unity power factor at the point of interconnection.

**Figure 3e: Typical Parallel Generation Utilizing Inverter Technology  
With Assumed Producer Owned Protection ( $\geq 200$  KVA,  $\leq 34.5$  kV)**



- Notes:
1. Protective devices required by SCE for all installations.  $\frac{27}{59}$  shall be a 3 $\emptyset$  unit or two 1 $\emptyset$  units.
  2. UL1741 certified inverters meet noted protection requirements without additional relays provided all inverters are UL1741 compliant.
  3. Recommended for three phase generators.
  4. Transformation as required by SCE or the Producer.
  5. Load break switch to be installed when required by SCE's Distribution Design Standards.
  6. Drawing does not show metering requirements.
  7. Producer is responsible for other protective devices not shown on the diagram because of large variations with type of inverter.

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### 3.2.1 The Producer shall provide adequate protective devices

#### *Applicable to Generation Facilities*

- a) Detect and clear the generator(s) from short circuits or grounds on the SCE system serving the Producer.
- b) Detect the voltage and frequency changes that can occur if the SCE system serving the Producer is disconnected from the main system, and clear the Producer's generating facilities from the islanded system.
- c) Prevent reparalleling the Producer's generation, after an incident of trouble, unless the SCE service voltage has been of normal magnitude and frequency continuously for a pre-determined period of time (typically five minutes).

### 3.2.2 Protection devices which may be required to satisfy the above Requirements

#### *Applicable to Generation Facilities*

- a) **Phase over-current trip devices** (Device 51, 51V, or 67V)

In most cases these will have to be voltage-restrained or voltage-controlled over-current relays in order to provide coordination with SCE relays.

- b) **Residual over-current or over-voltage relays to trip for ground faults on the SCE system** (Devices 51N or 59G)

The required type of device (51N or 59G) depends on the characteristic of SCE's interconnecting system. Contact SCE for information for a specific location.

- c) **Under/over voltage relays** (Device 27/59)

Two over/under voltage relays measuring different phase-to-phase voltages or three over/under voltage relays each measuring a phase-to-neutral voltage is required. A single multiphase over/under voltage relay is acceptable if it has separate voltage measurement elements for each phase or phase pair. Under voltage relays should be adjustable from 75-90% of nominal voltage and have time delay to prevent unnecessary tripping on external faults. Over voltage relays should be adjustable from 110-120% of nominal voltage and be instantaneous or a combination of instantaneous and time delayed. Setting changes with temperature variation should not exceed  $\pm 2$  volts over the expected temperature range.

d) **Under/over frequency relays** (Device 81)

The under-frequency relay should be adjustable from 56.4 -59.5 Hz and the over-frequency relay from 60.5 to 61.7 Hz. Setting change with temperature variation over the expected range, or voltage variation over  $\pm 10\%$ , should not exceed  $\pm 0.05$  Hz.

e) **Phase sequence under-voltage relay** (Device 47/27)

To permit paralleling only when SCE voltage and phase sequence are normal.

f) **Automatic Separation:** In some cases, protective devices supplied with the generating equipment will meet some or all of these Requirements, provided that it is acceptable to trip the generator whenever the SCE source is lost. If the Producer desires to automatically separate from SCE and commence isolated operation upon loss of the SCE source, additional devices will be necessary to effect the separation.

g) **Large Generators:** In specific installations, particularly with large generators (over 10,000 kVA), SCE may require specific additional protection functions such as loss of excitation, loss of synchronism and over-excitation protection, if these conditions would have an impact on SCE's system.

### 3.2.3 Other protection devices for Category 2 Generation

#### *Applicable to Generation Facilities*

a) **Utility Quality Relays:** Depending on the size of the generating facility and the size of the distribution or subtransmission system to which it is connected, SCE may require the Producer to utilize "utility quality" protective relays. Such relays have more stringent tolerances and more widely published characteristics than "industrial quality" relays and have the ability to coordinate protective settings with utility settings. This Requirement will be invoked only if the generating facility is large enough to require close coordination with SCE relays. In general, installations aggregating less than 1,000 kVA will not be subject to this Requirement.

b) **Relay Operation Recorders:** All protective devices supplied to satisfy the Requirements in Category 2 generating facilities shall be equipped with operation indicators (targets) or shall be connected to an annunciator or event recorder so that it will be possible to determine, after the fact, which devices caused a particular trip.

c) **Relay Testing:** All protective devices supplied to satisfy the Requirements in this Category shall be tested by qualified personnel prior to SCE approving parallel operation,

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and at intervals at least as frequent as those used by SCE for the relays protecting the line(s) serving the Producer. These intervals are given in Table 5.3, in Section 5. Lines traversing fire hazardous areas are required to have their relays tested annually before May 1st. Special tests may also be requested by SCE to investigate apparent misoperations. Each routine or special test shall include both a calibration check and an actual trip of the circuit breaker from the device being tested. For each test a report shall be prepared and sent to SCE listing the tests made and the "as found" and "as left" calibration values.

- d) **Four-wire Multi-grounded Neutral Distribution Circuits:** In projects where the Producer is served from an SCE four-wire multi-grounded neutral distribution circuit, adequate grounding must be provided to ensure neutral stability during accidental isolation of the line from the main system. This is necessary to avoid dangerous over-voltages on other customers served from phase-to-neutral connected distribution transformers. Adequate grounding can be provided either by the use of a wye-delta main power transformer or by installing an appropriate grounding transformer. In order to limit the effects of such grounding on SCE's ground relay sensitivity, SCE may require that the grounding impedance be limited to the highest value suitable for neutral stabilization.

### **3.2.4 Exemption For Installing Phase Over-current Protective Devices**

#### *Applicable to Generation Facilities*

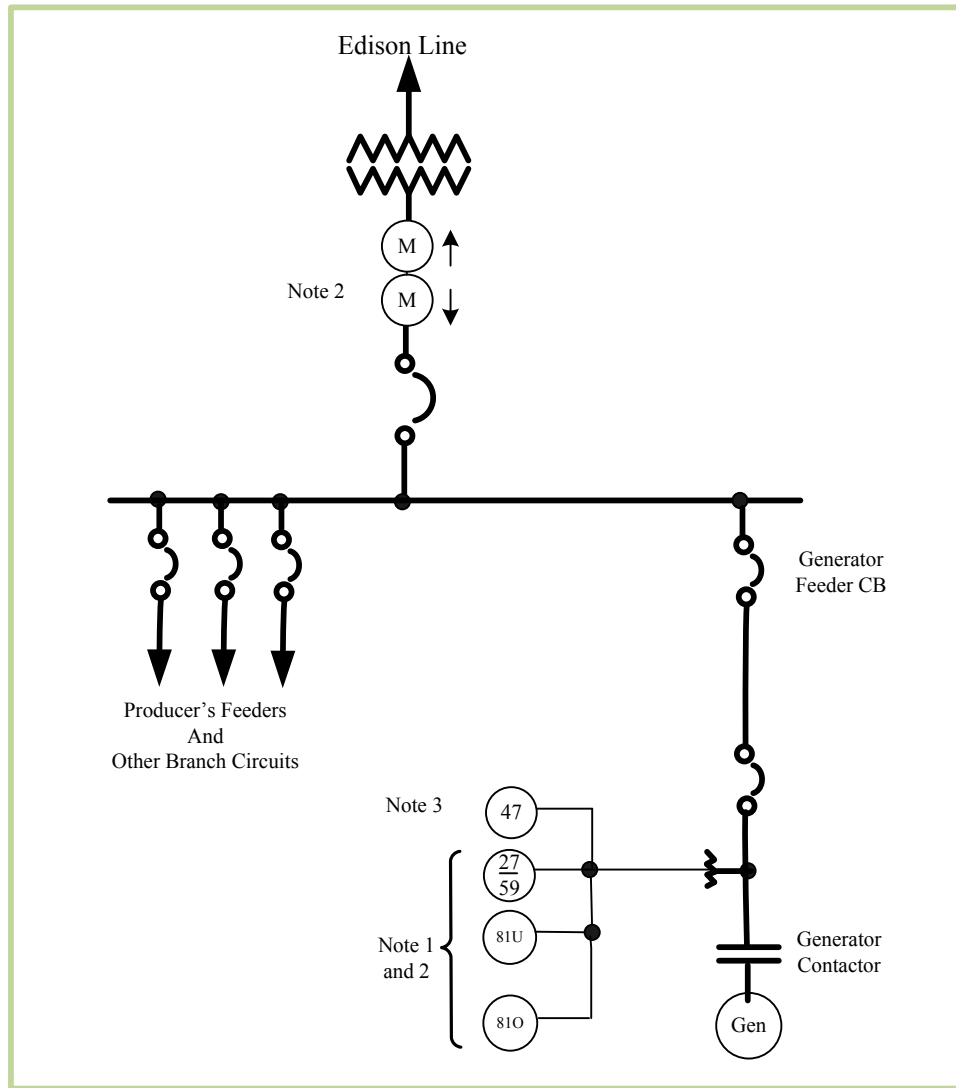
Where induction generators or static inverters are employed rather than synchronous machines, the phase over-current protective devices required by SCE generally will be waived since these generation sources will not deliver sustained over-currents. All other specified protective devices are required.

## **3.3 Category 3: Total Generation Less Than 200 kVA**

#### *Applicable to Generation Facilities*

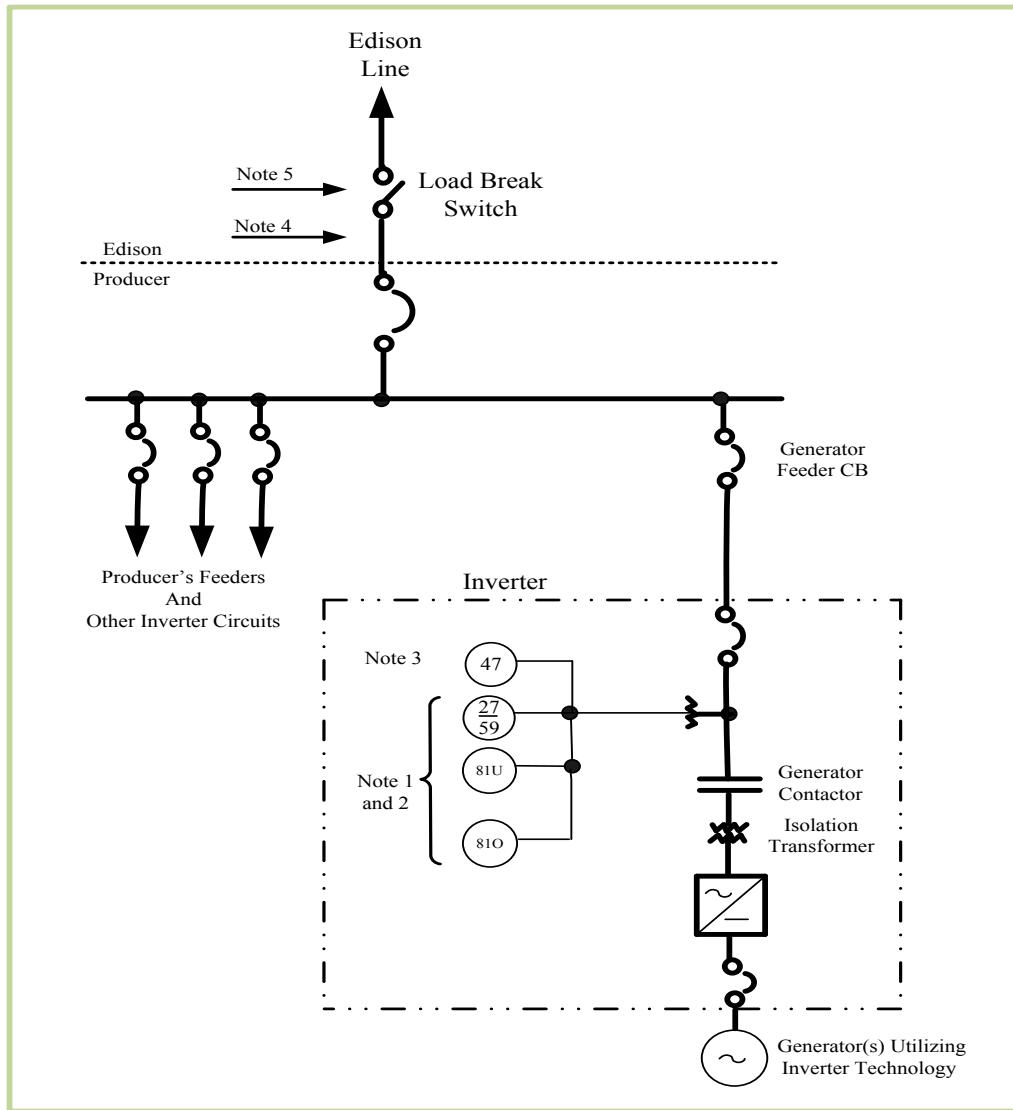
The following Requirements for small generating facilities are based on an assumed low density of parallel generation on the serving circuit. Other Requirements may be imposed should the density exceed a tolerable limit. Refer to Figure 3e.

**Figure 3f: Typical Parallel Generation Under 200 kVA**



- Notes:
1. Protective devices required by SCE for all installations. Other protective devices for generator not shown because of large variations with type of generator.
  2. Self-contained metering is typical.
  3. Required for three phase generators.

**Figure 3g: Typical Parallel Generation Utilizing Inverter Technology  
With Assumed Producer Owned Protection (< 200 KVA, ≤ 34.5 kV )**

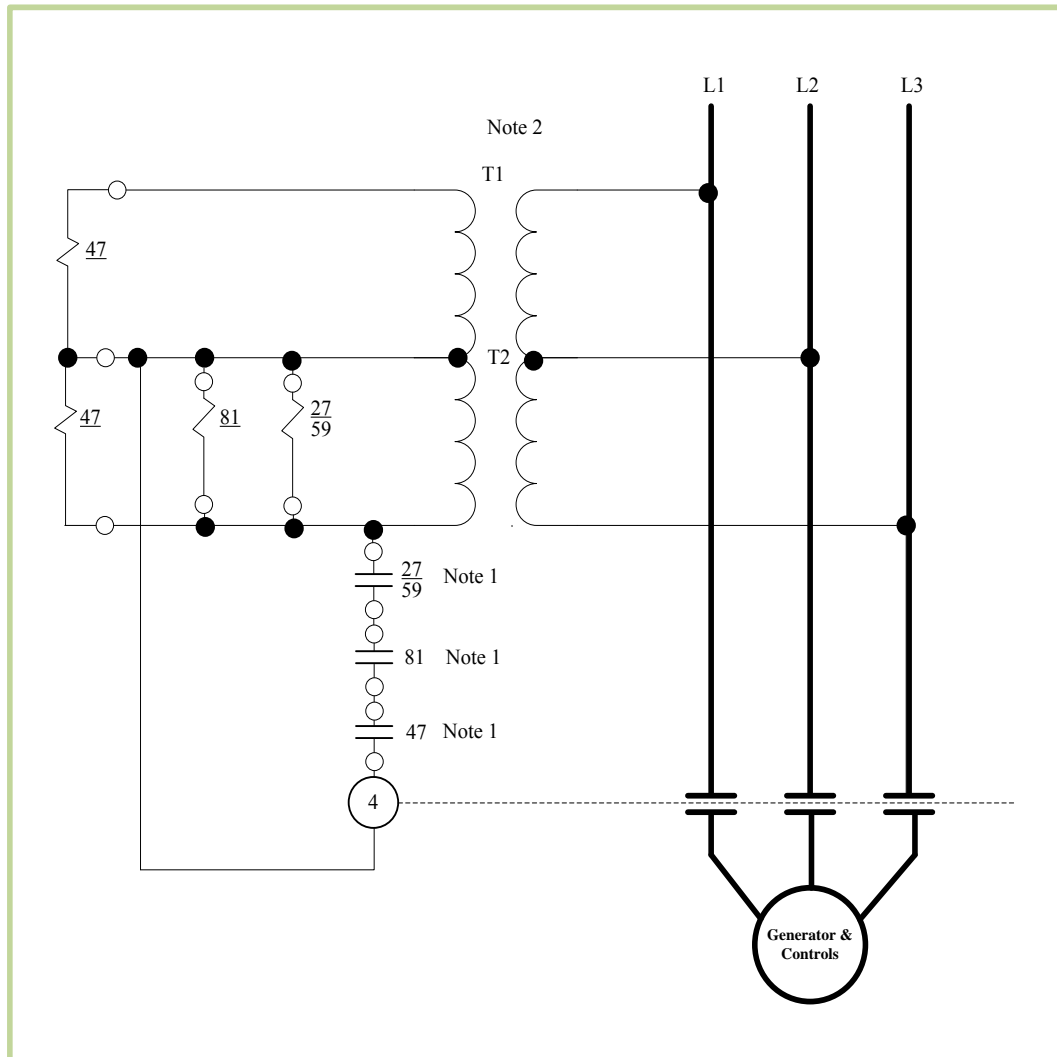


- Notes:
1. Protective devices required by SCE for all installations.  $\frac{27}{59}$  shall be a 3Ø unit or two 1Ø units.
  2. UL1741 certified inverters meet noted protection requirements without additional relays provided all inverters are UL1741 compliant.
  3. Recommended for three phase generators.
  4. Transformation as required by SCE or the Producer.
  5. Load break switch to be installed when required by SCE's Distribution Design Standards.
  6. Drawing does not show metering requirements.
  7. Producer is responsible for other protective devices not shown on the diagram because of large variations with type of inverter.

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- a) **Line Voltage Relay or Contactor:** Producer generator controls are to be equipped with a line voltage relay or contactor which will prevent the generator from being connected to a de-energized or single-phased (if normally three-phase) source. This relay is to disconnect the generator from a de-energized utility line and prevent its reconnection until the line has been re-energized by SCE and has maintained nominal voltage and frequency continuously for a pre-determined period of time (typically five minutes).
  - b) **Relays to Detect Islanding:** Producer generators are to be equipped with over/under frequency and over/under voltage relays for islanding detection. These relays must meet the specifications listed in Section 3.2.2, paragraphs (c) and (d). The relays may be arranged to de-energize the contactor as shown in Figure 3f. The Producer generator islanding protection must be able to detect an islanded condition and cease to energize SCE's distribution system within two seconds. Other requirements may be imposed on those installations unable to meet this requirement.
  - c) **Fault Detection:** The Producer shall provide adequate protective relays to detect and clear the generator(s) from short circuits or grounds on the SCE system serving the Producer.
  - d) **Four-wire Multi-grounded Neutral Distribution Circuits:** In projects where the Producer is served from an SCE four-wire multi-grounded neutral distribution circuit, adequate grounding must be provided to ensure neutral stability during accidental isolation of the line from the main system.

**Figure 3h: Typical Relay/Contactor Arrangement Under 200 kVA**

This drawing is intended to show the relay/contactor arrangement only. Other over-current or switching devices may be required by local authorities.



- Notes:
1. Contacts closed with normal voltage, frequency and phase sequence.
  2. Control transformers as required to match relay/contactor voltage to supply voltage. Arrangement shown is for three phase system. For single phase omit L3, T1, Dev. 47.

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- e) **Dedicated Distribution Transformer:** SCE may require the Producer to be served through a dedicated distribution transformer which serves no other customers. The purpose of the dedicated transformer is to confine any voltage fluctuations or harmonics produced by the generators to the Producer's own system.
  - f) **Harmonic Requirements for Inverters:** See "Voltage Imbalance and Abnormal Waveforms" Section 5.10.
  - g) **SCE Telecommunications:** Typically not required for protective purposes in Category 3 generating facilities except as required to coordinate with SCE's protective relays.
  - h) **Exception to Protection Devices:** Producers generating facilities may, as an alternative to the Requirements specified in this Category 3 generating facility section above, utilize an approved inverter/interface device meeting applicable safety and performance standards established by the National Electrical Code, the Institute of Electrical and Electronics Engineers ("IEEE"), and accredited testing laboratories such as Underwriters Laboratories ("UL"). These Requirements include, but are not limited to, the provisions of IEEE Standard 929, IEEE Standard 1547, and UL Standard 1741.

### 3.4 Breaker Duty and Surge Protection

#### *Applicable to Generation, Transmission, and End-User Facilities*

##### 3.4.1 SCE Duty Analysis

The recognized standard for circuit breakers rated on a symmetrical current basis is IEEE Standard C37.010-1999, "IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis," and ANSI/IEEE Standard C37.5 for circuit breakers rated on a total current basis. SCE will review breaker duty and surge protection to identify any additions required to maintain an acceptable level of SCE system availability, reliability, equipment insulation margins, and safety. Also, the management of increasing short-circuit duty of the transmission system involves selecting the alternative that provides the best balance between cost and capability. System arrangements must be designed so that the interrupting capability of available equipment is not exceeded.

When studies of planned future system arrangements indicate that the short-circuit duty will reach the capability of existing breakers, consideration should be given to the following factors:

- 
- a) Methods of limiting duty to the circuit breaker capability, or less:
    - 1. Delooping or rearranging transmission lines at substations;
    - 2. Split bus arrangements.
  - b) Magnitude of short circuit duty.
  - c) The effect of future projects on the duty.
  - d) Increasing the interrupting capability of equipment.
  - e) The ability of a particular breaker to interrupt short circuits considering applicable operating experience and prior test data.

Please note that SCE performs an annual short circuit duty analysis, which may include reevaluation of the facility breakers.

### **3.4.2 Customer Owned Duty/Surge Protection Equipment**

In compliance with Good Utility Practice and, if applicable, the Requirements of SCE's Interconnection Handbook, the INTFAC owner shall provide, install, own, and maintain relays, circuit breakers and all other devices necessary to remove any fault contribution of the INTFAC to any short circuit occurring on the SCE system not otherwise isolated by SCE's equipment, such that the removal of the fault contribution shall be coordinated with the protective requirements of the SCE system. Such protective equipment shall include, but not limited to, a disconnecting device and a fault current-interrupting device located between the INTFAC and the SCE system at a site selected upon mutual agreement (not to be unreasonably withheld, conditioned or delayed) of the Parties. The INTFAC owner shall be responsible for protection of the INTFAC and other equipment from such conditions as negative sequence currents, over- or under-frequency, sudden load rejection, over- or under-voltage, and generator loss-of-field. The INTFAC owner shall be solely responsible to disconnect their facility if conditions on the SCE system are impacted by the INTFAC.

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## Section 4: Miscellaneous Requirements:

### 4.1 Transmission Facilities Requirements

#### *Applicable to Transmission Facilities*

The INTFAC shall ensure that its overhead transmission facilities are constructed to a minimum of General Order 95 [Rules for Overhead Electric Line Construction](#) standards when facilities are built within California and to [National Electric Safety Code](#) standards when facilities are built outside of California. The INTFAC shall ensure that its underground transmission facilities are constructed to a minimum of General Order 128 [Rules for Construction of Underground Electric Supply and Communication Systems](#) when facilities are built within California and to National Electric Safety Code standards when facilities are built outside of California. Where facilities are intended to be owned by SCE, additional design requirements apply and must be consistent with SCE's design standards.

### 4.2 Power System Stabilizers (PSS)

#### *Applicable to Generation Facilities*

All new Producers' synchronous generators, larger than 30 MVA and interconnecting at a voltage 60 kV or higher are required to install PSS with a suitable excitation system, unless an exemption has been obtained from WECC. Suitable excitation systems are defined in the WECC report; "Criteria to Determine Excitation System Suitability for PSS," dated December 1992.

Unless an exemption has been received from the WECC, all new generators are assumed suitable for PSS, and must abide by the following Requirements:

- a) The generator excitation system must be equipped with a power system stabilizer (PSS). The PSS improves stability in the electrical system when system power disturbances occur.
- b) The PSS equipment must be approved by SCE prior to installation and operation.
- c) The PSS must be calibrated and operated in accordance with WECC standard procedures for calibration, testing, and operation of PSS equipment.
- d) Calibration and test reports must be submitted to SCE for review and approval. The generating facility shall not be considered operational until calibration of the PSS has been performed to SCE's satisfaction.

- 
- e) The PSS shall be properly maintained and in service when the generator is on line for power production.

In addition to the foregoing Requirements, Producers must conform to all applicable current or future WECC Criteria. Specific to PSS, these Criteria currently include “WECC Power System Stabilizer Design and Performance Criteria,” approved by the Technical Operations Subcommittee, September 15, 2003.

### **4.3 Governor “Droop” Shall Be Set At 5%**

#### *Applicable to Generation Facilities*

All new Producers’ generators having suitable systems must comply with the WECC minimum operating reliability criteria for governor droop.

These Requirements are necessary to provide an equitable and coordinated system response to load/generation imbalances. Governor droop shall be set at 5%. Governors shall not be operated with excessive dead-bands, and governors shall not be blocked unless required by regulatory mandates.

### **4.4 Wind Turbine Generating Facilities**

#### *Applicable to Generation Facilities*

#### **4.4.1 Wind Turbine Set-Back Criteria**

- a) The Producer shall locate its wind-driven generating unit such that it does not encroach onto SCE transmission right of way or edge of any electric operating property.
- b) The Producer shall be responsible for performing its appropriate grounding requirements for its wind-driven generating units.

#### **4.4.2 Generator Electric Grid Fault Ride-Through Capability and Power Factor Criteria**

SCE currently supports a Low Voltage Ride-Through Criterion that the WECC has adopted to ensure continued reliable service. The Criteria are summarized as follows:

- a) Generator is to remain in-service during system faults (three phase faults with normal clearing and single-line-to-ground with delayed clearing) unless clearing the fault effectively disconnects the generator from the system.
- b) During the transient period, the generator is required to remain in-service for the low voltage and frequency excursions specified in WECC Disturbance-Performance Table of

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“Allowable Effects on Other Systems” as applied to load bus constraint. These performance criteria are applied to the generator interconnection point, not the generator terminals.

- c) Generators may be tripped after the fault period if this action is intended as part of a Special Protection Scheme.
- d) This Standard will not apply to individual units or to a site where the sum of the installed capabilities of all machines is less than 10MVA, unless it can be proven that reliability concerns exist.
- e) The performance criterion of this Standard may be satisfied with performance of the generators or by installing equipment to satisfy the performance criteria.
- f) The performance criterion of this Standard applies to any generation independent of the interconnected voltage level.

No exemption from this Standard will be given because of minor impact to the interconnected system. This criterion also applies to existing generators that go through any refurbishments or any replacements.

#### **4.5 Reclosing Circuit Breakers and Hot Line Reclose Blocking**

##### ***Applicable to Generation Facilities***

Because most short circuits on overhead lines are of a temporary nature, it is SCE's practice to reclose the circuit breakers on such lines within a few seconds after they have automatically tripped. This practice improves continuity of service to all SCE's customers. The protective relays specified by SCE for parallel generation interfaces are intended to disconnect the generating facilities from faulty or isolated lines before reclosing occurs. Should the Producer desire additional protection against the possibility that reclosing might occur with his generator still connected to the line (a potentially damaging occurrence for synchronous generators), SCE can provide, at the Producer's expense, "Hot Line Reclose Blocking" at the necessary points on its system. Transfer trip protection may be required to facilitate restoration of service to SCE's customers. SCE's preference is to avoid such equipment because of the possible adverse effects on service continuity and the problems of moving or rearranging the equipment to accommodate system changes. Costs for installing, maintaining, and/or rearranging such equipment will be borne by the Producer(s) requesting the equipment.

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## 4.6 Unbalanced Currents

### *Applicable to Generation Facilities*

Producers with three-phase generators should be aware that certain conditions in the utility system may cause negative sequence currents to flow in the generator. It is the sole responsibility of the Producer to protect its equipment from excessive negative sequence currents.

## 4.7 Sub-Synchronous Resonance Studies

### *Applicable to Generation and Transmission Facilities*

Generators installed near series compensated lines or Flexible AC Transmission Systems (FACTS) may be exposed to Sub-Synchronous Resonance (SSR) conditions which must be evaluated by the Producer. SSR occurs when the network natural frequencies (below fundamental frequencies) coincide with the turbine-generator torsional-mode frequencies causing the turbine-generator to stress that may result in shaft failure. The turbine-generator and the system may interact with SSR into two main ways: Torsional Interaction (TI) and Torque Amplification (TA). In order to evaluate a potential SSR condition on a new generator installation near series compensated lines or FACTS devices a screening study needs to be conducted to identify any TA or TI impact on the series compensation level or FACTS devices controls. If a case is identified by the initial screening process (Frequency Scanning Study) a more detailed time domain study is required to quantify the potential damage and provide with mitigation measures. Customer owned transmission lines that have a series capacitor attached to the line and wish to interconnect to SCE, must demonstrate to SCE that SSR studies have been performed on their line.

## 4.8 Automatic Voltage Regulators (AVR)

### *Applicable to Generation Facilities*

Generating units 10 MVA and larger shall be equipped with automatic voltage control equipment. All generating units with automatic voltage control equipment shall normally be operated in voltage control mode. These generating units shall not be operated in other control modes (e.g., constant power factor control) unless authorized to do so by the balancing authority. The control mode of generating units shall be accurately represented in operating studies.

All new Producers' synchronous generators, regardless of size and interconnecting at a voltage 60 kV or higher, must abide by the following Requirements:

- 
- a) The synchronous generator shall have an excitation system with a continuously acting Automatic Voltage Regulator (AVR).
  - b) The AVR equipment must be approved by SCE prior to installation and operation.
  - c) The AVR must be calibrated and operated in accordance with WECC standard procedures for calibration, testing, and operation of AVR equipment.
  - d) Calibration and test reports must be submitted to SCE for review and approval. The generating facility shall not be considered operational until calibration of the AVR has been performed to SCE's satisfaction.
  - e) The AVR shall be properly maintained and in service when the generator is on line for power production.

***Applicable to Generation, Transmission, and End-User Facilities***

Automatic voltage control equipment on generating units, synchronous condensers, and Flexible Alternating Current Transmission System (FACTS) shall be kept in service to the maximum extent possible with outages coordinated to minimize the number out of service at any one time. Such voltage control equipment shall operate at voltages specified by the balancing authority operator.

#### **4.9 Underfrequency Relays**

***Applicable to Generation Facilities***

For voltage classes 161 kV and above, it is essential that the underfrequency protection of generating units and any other manual or automatic actions are coordinated with underfrequency load shedding relay settings. For further information, please refer to Section 3.2.2.d.

***Applicable to Transmission and End-User Facilities***

Since the facilities of the SCE system may be vital to the secure operation of the Interconnection, CAISO/SCE shall make every effort to remain connected to the Interconnection. However, if the system or control area determines that it is endangered by remaining interconnected, it may take such action as it deems necessary to protect the system.

Intentional tripping of tie lines due to underfrequency is permitted at the discretion of SCE's system, providing that the separation frequency is no higher than 57.9 Hz with a one second

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time delay. While acknowledging the right to trip tie lines at 57.9 Hz, the preference is that intentional tripping not be implemented.

## **4.10 Insulation Coordination**

### *Applicable to Generation, Transmission, and End-User Facilities*

Insulation coordination is the selection of insulation strength and practice of correlating insulation levels of equipment and circuits with the characteristics of surge-protective devices such that the insulation is protected from excessive overvoltages. Insulation coordination must be done properly to ensure electrical system reliability and personnel safety.

The INTFAC shall be responsible for an insulation coordination study to determine appropriate surge arrester class and rating on the INTFAC equipment. In addition, the INTFAC is responsible for the proper selection of substation equipment and their arrangements from an insulation coordination standpoint.

Basic Surge Level (BSLs), surge arrester, conductor spacing and gap application, substation and transmission line insulation strength, protection, and shielding shall be documented and submitted for evaluation as part of the interconnection plan.

## **4.11 Ratings**

### **4.11.1 Facility Ratings**

#### *Applicable to Generation, Transmission, and End-User Facilities*

The ratings of facilities are the responsibility of the owner of those facilities. Ratings of facilities must conform to NERC Standard [FAC-008-1 Facility Ratings Methodology](#).

### **4.11.2 Ratings Provided by Equipment Manufacturers**

#### *Applicable to Generation, Transmission, and End-User Facilities*

Equipment installed on the SCE system is rated according to the manufacturer's nameplate or certifications, and ANSI/IEEE standards. The manufacturer's nameplate rating is the normal rating of the equipment. ANSI/IEEE standards may allow for emergency overloads above the normal rating under specified conditions and often according to an engineering calculation.

Emergency loading may impact the service life of the equipment. In some cases the manufacturer has certified equipment for operation at different normal or emergency loads based on site specific operation conditions. Older technology equipment is rated according to the standards under which it was built unless the manufacturer, ANSI/IEEE standards, or

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SCE's determination indicates that a reduced rating is prudent or an increase rating is justified.

#### **4.11.3 Rating Practice**

##### ***Applicable to Generation, Transmission, and End-User Facilities***

The normal and emergency ratings of transmission lines or the transformation facilities shall equal the least rated component in the path of power flow.

#### **4.11.4 Ambient Conditions**

##### ***Applicable to Generation, Transmission, and End-User Facilities***

Since SCE's territory is in a year-round moderate climate, SCE does not establish equipment ratings based on seasonal temperatures. That is, SCE standard ratings for normal and emergency ratings are the same throughout the year and reflect summer ambient temperatures coincident with ANSI/IEEE standards, i.e., 40°C (104°F). However, in some cases SCE may calculate site-specific ratings that consider the local ambient conditions based on ANSI/IEEE rating methods.

#### **4.11.5 Transmission Lines**

##### ***Applicable to Generation, Transmission, and End-User Facilities***

The transmission circuit rating is determined according to the least rated component in the path of power flow. This comprises of the transmission line conductor, the series devices in the line, the allowable current that will not cause the conductors to sag below allowable clearance limits, and the termination equipment.

#### **4.11.6 Conductors**

##### ***Applicable to Generation, Transmission, and End-User Facilities***

The transmission line conductor ratings are calculated in accordance with ANSI/IEEE 738-1993. For Aluminum Conductor Steel Reinforced (ACSR) conductor the normal conductor rating allows a total temperature of 90°C and the emergency rating allows 135°C. Similarly, for aluminum and copper conductors SCE permits 85°C and 130°C. For Aluminum Conductor Steel Supported (ACSS), SCE base the normal rating at 120°C, and 200°C for the emergency rating. Higher or lower temperature limits may be permitted as appropriate depending on engineering justification.

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#### **4.11.7 Series and Shunt Compensation Devices**

##### *Applicable to Generation, Transmission, and End-User Facilities*

Series capacitor and reactors are only permitted to be loaded to ANSI/IEEE limits or as specified by the manufacturer. VAR compensators shall be rated according to the ANSI/IEEE standards where applicable and according to the manufacturer's limitations. These ratings are reported to CAISO Transmission Register. Shunt capacitors and reactors are not in the path of power flow so they are not directly a "limiting component." However, their reactive power capacity is reported to CAISO Transmission Register.

#### **4.11.8 Terminal Equipment**

##### *Applicable to Generation, Transmission, and End-User Facilities*

Terminal equipment comprises: circuit breakers, disconnect switches, jumpers, drops, conductors, buses, and wave-traps, i.e., all equipment in the path of power flow that might limit the capacity of the transmission line or transformer bank to which it is connected. The normal and emergency ampere rating for each termination device is reported to CAISO in its Transmission Register.

#### **4.11.9 Transformer Bays**

##### *Applicable to Generation, Transmission, and End-User Facilities*

The rating of a transformer bay is determined by the least rated device in the path of power flow. This comprises ratings of the transformer, the transformer leads, the termination equipment, and reduced parallel capacity where applicable. The transformer rating is compared to the termination equipment ratings and lead conductors to establish the final transformation rating based on the least rated component. All of the above ratings are reported to the CAISO Transmission Register.

#### **4.11.10 Transformer Normal Ratings**

##### *Applicable to Generation, Transmission, and End-User Facilities*

The "normal" rating is the transformer's highest continuous nameplate rating with all of its cooling equipment operating. The only exception is when a special "load capability study" has been performed showing that a specific transformer is capable of higher than nameplate loading and for which the test data or calculations are available.

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#### **4.11.11 Transformer Emergency Ratings**

##### *Applicable to Generation, Transmission, and End-User Facilities*

A transformer's emergency rating is arrived at by one of two methods. First, if no overload tests are available then a 10% overload is allowed. Second, if a factory heat-run or a load capability study has been performed, the emergency rating may be as high as 20% above normal as revealed by the test. For transformers on the transmission system, i.e., primary voltage of 500 kV, the allowed duration of the emergency loading is 24-hours. For transformers with primary voltage of 161 kV to 230 kV, the allowed duration is thirty days.

#### **4.11.12 Parallel Operation of Transformers**

##### *Applicable to Generation, Transmission, and End-User Facilities*

When two or more transformers are operated in parallel, consideration is given to load split due to their relative impedances such that full parallel capacity is not usually realized. The permissible parallel loading is calculated according to ANSI/IEEE standards.

#### **4.11.13 Relays Protective Devices**

##### *Applicable to Generation, Transmission, and End-User Facilities*

In cases where protection systems constitute a loading limit on a facility, this limit is the rating for that facility. These limiting factors are reported to the CAISO Transmission Register and are so noted as to the specific reason, e.g., "limited to 725A by relay setting."

#### **4.11.14 Path Ratings**

##### *Applicable to Generation, Transmission, and End-User Facilities*

As stated in Section 2 of the WECC Procedures for Project Rating Review, new facilities and facility modifications should not adversely impact accepted or existing ratings regardless of whether the facility is being rated. New or modified facilities can include transmission lines, generating plants, substations, series capacitor stations, remedial action schemes or any other facilities affecting the capacity or use of the interconnected electric system.

### **4.12 Synchronizing of Facilities**

##### *Applicable to Generation, Transmission, and End-User Facilities*

Testing and synchronizing of an INTFAC may be required depending on SCE system conditions, ownership or policy, and will be determined based on facility operating parameters. Such procedures should provide for alternative action to be taken if lack of information or loss

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of communication channels would affect synchronization.

Appropriate operating procedures and equipment designs are needed to guard against out-of-sync closure or uncontrolled energization. (Note: SCE's transmission lines utilize ACB phase rotation, which is different than the national standard phase rotation). The INTFAC is responsible to know and follow all applicable regulations, industry guidelines, safety requirements, and accepted practice for the design, operation and maintenance of the facility.

Synchronizing locations shall be determined ahead of time; required procedures shall be in place and be coordinated with SCE. SCE and the INTFAC shall mutually agree and select the initial synchronization date. The initial synchronization date shall mean the date upon which a facility is initially synchronized to the SCE transmission system and upon which trial operation begins.

For additional technical information regarding the synchronizing of generators refer to section 3 Protection Requirements.

#### **4.13 Maintenance Coordination and Inspection**

##### *Applicable to Generation, Transmission, and End-User Facilities*

The security and reliability of the interconnected power system depends upon periodic inspection and adequate maintenance of the INTFAC and associated equipment, including but not limited to control equipment, communication equipment, relaying equipment and other system facilities. Entities and coordinated groups of entities shall follow CAISO procedures and are responsible for disseminating information on scheduled outages and for coordinating scheduled outages of major facilities which affect the security and reliability of the interconnected power system.

#### **4.14 Abnormal Frequency and Voltages**

##### **4.14.1 Joint Reliability Procedures**

##### *Applicable to Generation, Transmission, and End-User Facilities*

Where specific transmission issues have been identified, those entities affected by and those entities contributing to the problem shall develop joint procedures for maintaining reliability.

##### **4.14.2 Voltage and Reactive Flows**

##### *Applicable to Generation, Transmission, and End-User Facilities*

CAISO shall coordinate the control of voltage levels and reactive flows during normal and emergency conditions. All operating entities shall assist with the CAISO's coordination efforts.

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### **4.14.3 Transfer Limits Under Outage and Abnormal System Conditions**

#### ***Applicable to Generation, Transmission, and End-User Facilities***

In addition to establishing total transfer capability limits under normal system conditions, transmission providers and balancing authority shall establish total transfer capability limits for facility outages and any other conditions such as unusual loads and resource patterns or power flows that affect the transfer capability limits.

## **4.15 Communications and Procedures**

### **4.15.1 Use of Communication System**

#### ***Applicable to Generation, Transmission, and End-User Facilities***

It is essential to establish and maintain communications with the SCE Grid Control Center (GCC), the Alternate Grid Control Center (AGCC) or a jurisdictional Switching Center should a temporarily attended station or area of jurisdiction become involved in a case of system trouble. It is equally important that communication services be kept clear of nonessential use during times of system trouble to facilitate system restoration or other emergency operations.

### **4.15.2 Special Protection Schemes Communication Equipment Requirements**

#### ***Applicable to Generation, Transmission, and End-User Facilities***

INTFACs will require the necessary communication equipment for the implementation of Special Protection Systems (SPS). This equipment provides line monitoring and high speed communications between the INTFAC breaker and the central control facility, utilizing applicable protocols. This Remedial Action Scheme (RAS) may also be applied to generators that may be required to trip in order to relieve congestion on transmission facilities. Thus, allowing an SPS to incorporate disconnection into automatic control algorithms under contingency conditions, as needed.

The SPS is a fully redundant system. The following paragraph is an excerpt from the WECC Remedial Action Scheme Design Guide that specifies the Philosophy and General Design Criteria for SPS redundancy. *“Redundancy is intended to allow removing one scheme following a failure or for maintenance while keeping full scheme capability in service with a separate scheme. Redundancy requirements cover all aspects of the scheme design including detection , arming, power, supplies, telecommunications facilities and equipment, logic controllers (when applicable), and RAS trip/close circuits.”*

Excerpt from: WECC Remedial Action Scheme Design Guide (11/28/2006)

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### **4.15.3 Critical System Voltage Operation**

#### ***Applicable to Generation, Transmission, and End-User Facilities***

Voltage control during abnormal system configurations requires close attention with consideration given to what operations will be necessary following loss of the next component. Voltages approaching 10% above or below the normal value are considered critical with rate of change being of principal importance.

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## Section 5: General Operating Requirements:

### *Applicable to Generation, Transmission, and End-User Facilities*

- a) **System Operating Bulletins:** The INTFAC connecting into the SCE system may be subject to operating requirements established by SCE, the CAISO or both. SCE's general operating Requirements are discussed in the sections below. SCE may also require additional operating Requirements specific to an INTFAC. If so, these Requirements will be documented in SCE's System Operating Bulletins (SOB), Substation Standard Instructions (SSI), and/or interconnection and power purchase agreements. SCE's SOBs and/or SSIs specific to the INTFAC and any subsequent revisions will be provided by SCE to the INTFAC as they are made available.
- b) **INTFAC's Responsibility:** It is the INTFAC's responsibility to comply with applicable operating requirements. Operating procedures are subject to change as system conditions and system needs change. Therefore it is advisable for the INTFAC to regularly monitor operating procedures that apply to its generating facilities. The CAISO publishes its operating procedures on its internet site, but it is prudent for the INTFAC to contact the CAISO for specific Requirements.
- c) **Quality of Service:** The interconnection of the INTFAC's equipment with the SCE system shall not cause any reduction in the quality of service being provided to SCE's customers. If complaints result from operation of the INTFAC, such equipment shall be disconnected until the problem is resolved.
- d) **SCE Circuits:** INTFACs are not permitted to energize any de-energized SCE circuit.
- e) **Operate Prudently:** The INTFAC will be required to operate its facility in accordance with prudent electrical practices.
- f) **Protection in Service:** The generating facility shall be operated with all of required protective apparatus in service whenever the generating facility is connected to, or is operated in parallel with, the SCE electric system. Redundant protective devices may be provided at the Producer's expense if the generator is to be operated in parallel during routine testing of or failure of a protective device. Any deviation for brief periods of emergency may only be by agreement of SCE and is not to be interpreted as permission for subsequent incidents.

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*Applicable to Generation Facilities*

- g) **Added Facilities Documentation:** The Producer may not commence parallel operation of generator(s) until final written approval has been given by SCE. As part of the approval process, the Producer shall provide, prior to the commencement of parallel operation, all documents required by SCE to establish the value of any facilities installed by the Producer and deeded to SCE for use as added facilities. SCE reserves the right to inspect the Producer's facility and witness testing of any equipment or devices associated with the interconnection.

## 5.1 Generating Facility Records and Data

*Applicable to Generation Facilities*

SCE requires generating facility operating records and data from the Producer in order for SCE to plan and reliably operate its electrical system. Some Producers may be subject to similar record and data obligations from the CAISO. If so, the Producer may satisfy many of SCE's operating record and data requirements by giving SCE permission to access the Producer's information held by the CAISO.

Table 5.1 illustrates typical sizes of generating facilities and typical means of communicating generating facility operating records and data to SCE. Typically, large and medium sized generating facilities are required to install real-time telemetering, but small generating facilities may be excluded from many record and data requirements. Section 7 of this document describes the real-time telemetering<sup>1</sup> hardware requirements. The following two sub-sections describe generating facility operating records and data Producers are required to submit to SCE by real-time telemetering, voice communication or equivalent means.

SCE will require submission of additional records if such records are necessary for SCE to reliably operate and plan its electrical system.

**Table 5.1: Typical Communication Requirements Per Generating Facility Size**

Aggregate Generation Facility Size	Real-time Telemetering	Voice
Gen. $\geq$ 1 MW	Required	Required
Gen. $<$ 1 MW	Maybe	Maybe

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<sup>1</sup> Generation up to 10 MW may rely on the Public Switched Telephone Network (PSTN) as the primary means of maintaining operating communications. Generation greater than 10 MW should provide an alternate means of communication in addition to the PSTN to insure availability in the event of unplanned outage or emergency.

## 5.2 Operating Records and Data the Producer Must Provide to SCE

### *Applicable to Generation Facilities*

- a) SCE requires some Producers to maintain operating communications with an SCE designated switching center. These communications provide SCE operating records and data about the Producer's generating facilities in order for SCE to reliably operate its electrical system. Generally, Producers with generating facility capacity of 1 MW or greater will have these Requirements, but it may be necessary for SCE to receive generating facility records for smaller generators if needed for reliability. Table 5.2 illustrates typical required generating facility records and data. SCE may require Producers to provide additional records than those shown in Table 5.2.

**Table 5.2: Typical Required Generating Facility Records and Data**

	<b>Generation Facility Record</b>	<b>Typical Size of Aggregate Generation<sup>2</sup> Facility</b>	<b>Delivery Date or Primary Communication Mode</b>	<b>Delivery Location</b>
1	System Parallel Operation Or Separation	> 200 kW	Timely by Voice	Designated SCE Switching Center
2	Scheduled And Unscheduled Outages	> 200 kW	<u>Scheduled Outages</u> Outage Duration    Adv. Notice < 1 day                24 Hours 1 day or more        1 Week Major overhaul      6 Months <u>Unscheduled Outages</u> Timely Communication Mode Voice	Designated SCE Switching Center
3	Levels Of Real And Reactive Power	≥ 1 MW	Real-time Telemetry	SCADA
4	Equipment Clearance	≥ 10 MW	Timely by Voice	Designated SCE Switching Center
5	Interruption event	> 200 kW	Timely after event by Voice	Designated SCE Switching Center
6	Gen. Circuit Breaker Status	≥ 10 MW	Real-time Telemetry	SCADA
7	Gen. on/off Status	≥ 10 MW	Real-time Telemetry	SCADA
8	Generator Terminal Voltage	≥ 10 MW	Real-time Telemetry	SCADA

<sup>2</sup> Aggregate generation is the total nameplate capacity of generating facilities at the generation site being interconnected or the total generation under one SCE account.

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- b) An interruption event is said to occur on an interconnection circuit when its closed energized circuit breaker has opened or trips and interrupts powerflow to/from SCE facilities. After experiencing an event, the Producer is required to submit the following event information to their Designated Switching Center in order for SCE to assess relay operations and system integrity.
- Date and time of trips by the interconnection circuit breaker
  - Generation facility status at time of incident (real & reactive power generation)
  - Relay operation indicator (target) operations
  - Oscillograph or Sequence of Event recorder records.

### **5.3 Operating Data and Records the Producer Must Provide SCE Upon Request**

#### *Applicable to Generation Facilities*

- a) The Producer will be required to keep a daily operations log (records) for the generating facility which must include levels of operating voltage, relay operations, information on maintenance outages, maintenance performed, availability, and circuit breaker trip operations requiring a manual reset. Producers with the necessary metering<sup>3</sup> will be required to log fuel consumption, cogeneration fuel efficiency kilowatts, kilovars, and kilowatt-hours generated and settings or adjustments of the generator control equipment and protective devices, and any significant events related to the operation of the generating facility, including but not limited to real and reactive power production; changes in operating status and protective apparatus operations; and any unusual conditions found during inspections. Changes in settings shall also be logged for Producer's generator(s) if it is "block-loaded" to a specific kW capacity.
- b) SCE, after giving written notice to the Producer, shall have the right to review and obtain copies of metering records and operations and maintenance logs of the generating facility.
- c) If a Producer's generating facility has a Nameplate Rating greater than one (1) megawatt, SCE may require the Producer to report to a designated SCE Switching Center twice a day at agreed upon times for:
- the current day's operation,
  - the hourly readings in kW of capacity delivered, and
  - the energy in kWh delivered since the last report.

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<sup>3</sup> Generators operating under the FERC QF status have additional metering installed.

## 5.4 Calibration of Producer Owned Protective Apparatus

### *Applicable to Generation Facilities*

The Producer must test the protective apparatus it owns on a routine basis in order to provide correct calibration and operation of the devices. Required test intervals of these protective apparatus have been established as shown in Table 5.3.

These test intervals are based on the nominal system voltage at the point of interconnection to SCE. SCE may require the Producer, at the Producer's expense, to demonstrate to SCE's satisfaction the correct calibration and operation of the Producer's protective apparatus at any time SCE reasonably believes that the Producer's protective apparatus may impair the SCE electric system integrity.

**Table 5.3: Required Test Intervals for Protective Devices**

	<b>Interconnection Voltage</b>	<b>Test Interval</b>	<b>Delivery Location</b>
1	≥200 kV	Every two years <sup>1</sup>	mail to: Manager, Grid Contracts, P.O. Box 800, 2244 Walnut Grove Avenue, Rosemead, California 91770
2	55 - 200 kV	Every four years <sup>1</sup>	mail to: Same
3	less than 55 kV	Every eight years <sup>2</sup>	mail to: Same
4	Frequency relays (all voltage levels) Electromechanical: Electronic:	Every  two years four years	mail to: Same
<p>1 The test interval may be extended by 2 years for self-monitoring microprocessor relays provided with failure alarms, e.g. from four years to six years.</p> <p>2 Interconnection protective relays on interconnections to lines listed in System Operating Bulletin 22 (fire hazard areas) must be tested <i>annually</i> before May 1 of each year.</p>			

## 5.5 Disconnecting Service to a Generation Facility

### *Applicable to Generation Facilities*

Applicable agreements and tariffs may state criteria for disconnection of generating facilities which are interconnected to SCE's system. In general, generating facilities may be curtailed or disconnected if SCE determines that their operation creates a threat to personnel or the electric system.

## 5.6 Voltage Variations

### *Applicable to Generation Facilities*

- a) **Voltage Regulation:** Operation of the Producer's generating facility shall not adversely affect the voltage regulation of that portion of the SCE system to which it is connected. Adequate voltage control shall be provided by the Producer to minimize voltage regulation on the SCE system caused by changing generator loading conditions. The step-up transformer ratio must be chosen such that the Producer can meet its voltage regulation obligations over the expected range of SCE system voltages. Step-up transformers must be equipped with no-load taps which provide  $\pm 5\%$  adjustment of the transformer ratio in 2.5% steps.
- b) **Exception:** The tap Requirement will be waived if the Producer submits a study to SCE which demonstrates to SCE's satisfaction that the Producer can meet its voltage regulation obligations over the expected range of system voltages specified by SCE.

Generator voltage schedule and transformer tap settings will be specified by SCE, as necessary, or the CAISO to ensure proper coordination of voltages and regulator action. It is the Producer's responsibility to ensure voltage-VAR schedule compliance. The following table illustrates whether SCE or the CAISO specifies these schedules.

**Table 5.4: Electric System Jurisdiction and Tap-setting Specification**

	CAISO Controlled Transmission System	SCE Controlled Subtransmission or Distribution
<b>Generating Facility Connected to:</b>		
<b>Voltage Schedule</b>	Specified by CAISO	Specified by SCE, as needed
<b>Transformer Tap Settings</b>	Specified by SCE $\pm 5\%$ in 2.5% steps	Specified by SCE $\pm 5\%$ in 2.5% steps

- c) **Transmission Voltages:** Expected transmission system operating voltages range from 160 to 164 kV for 161 kV nominal voltage, 220 to 240 kV for 220 kV nominal voltage, and 515 to 535 kV for 500 kV nominal voltage. Voltage regulation at a given location on the transmission system must follow the CAISO and SCE voltage schedules.
- d) **Distribution and Subtransmission Voltages:** In order to supply and maintain proper voltages for SCE's customers as required by the CPUC, SCE's primary distribution voltages (2.4 to 34.5 kV) and subtransmission voltages (55 to 115 kV) may fluctuate by as much as  $\pm 5\%$  from the nominal values (e.g., 12 kV  $\pm 5\%$ ; 34.5 kV  $\pm 5\%$ ; etc.). SCE uses

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various voltage regulation techniques to raise or lower primary distribution and subtransmission voltages in order to maintain the customer's service voltage at the desired level. Producers interconnected at primary distribution or subtransmission voltage levels must be able to withstand such voltage changes and to respond with proper power factor adjustment in order not to oppose or interfere with SCE's or the CAISO's voltage regulation processes.

## **5.7 VAR Correction**

### ***Applicable to Generation, Transmission, and End-User Facilities***

VAR correction will normally be planned for light load, heavy load and for system normal and contingency conditions. This is to be accomplished by providing transmission system VAR correction to minimize VAR flow and to maintain proper voltage levels. The planning of transmission system VAR requirements should consider the installation of shunt capacitors, shunt reactors and tertiary shunt reactors, synchronous condensers, FACTS and transformer tap changers. The guidelines for reactive planning are as follows:

#### **5.7.1 Interconnection**

##### ***Applicable to Generation, Transmission, and End-User Facilities***

Interconnection with other utilities will normally be designed with the capability of maintaining near-zero VAR exchange between systems. Entities interconnecting their transmission system with SCE's transmission system shall endeavor to supply the reactive power required on their own system, except as otherwise mutually agreed. SCE shall not be obligated to supply or absorb reactive power for the INTFAC when it interferes with operation of the SCE transmission system, limits the use of SCE interconnections, or requires the use of generating equipment that would not otherwise be required.

#### **5.7.2 Subtransmission System**

##### ***Applicable to End-User Facilities***

VAR correction will normally be planned for connection to 55 kV through 160 kV buses to correct for large customer VAR deficit, subtransmission line VAR deficit, and transformer A-Bank VAR losses, the objective being zero VAR flow at the high side of the A-Banks with VAR flow toward the transmission system on the high side of the A-Banks, if required. Adequate VAR correction shall be provided for maximum coincident customer loads (one-in-five year heat storm conditions), after adjusting for dependable local generation and loss of the largest local bypass generator.

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## 5.8 Voltage Regulation/Reactive Power Supply Requirements

### *Applicable to Generation, Transmission, and End-User Facilities*

Operating entities shall ensure that reactive reserves are adequate to maintain minimum acceptable voltage limits under facility outage conditions. Reactive reserves required for acceptable response to contingencies shall be automatically applied when contingencies occur. Operation of static and dynamic reactive devices shall be coordinated such that static devices are switched in or out of service so that the maximum reactive reserves are maintained on generators, synchronous condensers and other dynamic reactive devices.

### *Applicable to Transmission and End-User Facilities*

To ensure secure and reliable operation of the interconnected power system, reactive supply and reactive generation shall be properly controlled and adequate reactive reserves shall be provided. If power factor correction equipment is necessary, it may be installed by the INTFAC at the facility, or by SCE at SCE's facilities at the INTFAC's expense.

### *Applicable to Generation Facilities*

Generator VAR schedules, as needed, will be specified by SCE or the CAISO to ensure proper coordination of voltages. It is the Producer's responsibility to ensure voltage-VAR schedule compliance. If power factor correction equipment is necessary, it must be installed by the Producer at its facility at the Producer's expense to ensure the power factor at the point of interconnection meets the criteria in Table 5.5.

Note that the generator power factor capability for WDAT service is likely to require equipment capable of operating over the range of 0.9 lag to 0.95 lead in order to meet the Tariff Point of Delivery requirements.

**Table 5.5: Power Factor Criteria**

<b>Generating Facility Connected to:</b>	<b>CAISO Controlled Transmission System</b>	<b>SCE Controlled Subtransmission or Distribution</b>
<b>Power Factor</b>	Generator has the capability of 0.90 lagging to 0.95 leading.	At point of delivery, 0.95 lagging to 0.95 leading.

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## 5.8.1 Reactive Power Equipment – Induction Generators (in aggregate)

### 5.8.1.1 Facility Reactive Power Equipment Design

#### *Applicable to Generation, Transmission, and End-User Facilities*

INTFACs shall provide for the supply of its reactive requirements, including appropriate reactive reserves, and its share of the reactive requirements to support power transfers on interconnecting transmission circuits.

The reactive power equipment utilized by the INTFAC to meet SCE's Requirements must be designed to minimize the exposure of SCE's customers, SCE's electric system, and the electric facilities of others (i.e., other facilities and utilities in the vicinity) to:

- a) severe overvoltages that could result from self-excitation of induction generators,
- b) transients that result from switching of shunt capacitors,
- c) voltage regulation problems associated with switching of inductive and capacitive devices.
- d) unacceptable harmonics or voltage waveforms, which may include the effect of power electronic switching, and
- e) Voltage flicker exceeding SCE Voltage Flicker limits as indicated in SCE Transmission Planning Criteria and Guidelines Figure 4-1 "VOLTAGE FLUCTUATION DESIGN LIMITS".

### 5.8.1.2 Facility Reactive Power Equipment Design - provide variable source

#### *Applicable to Generation, Transmission, and End-User Facilities*

The reactive power equipment utilized by the INTFAC to meet SCE's Requirements must be designed to provide a variable source of reactive power (either continuously variable or switched in discrete steps). For discrete step changes, the size of any discrete step change in reactive output shall be limited by the following criteria:

- a) the maximum allowable voltage rise or drop (measured at the point of interconnection with the SCE system) associated with a step change in the output of the INTFAC's reactive power equipment must be less than or equal to 1%; and
- b) the maximum allowable deviation from an INTFAC's reactive power schedule (measured at the point of interconnection with the SCE system) must be less than or equal to 10% of the INTFAC's maximum (boost) reactive capability.

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## **5.8.2 Reactive Power Supply Requirements - Synchronous Generators**

### ***Applicable to Generation Facilities***

Producers connected to the SCE system and utilizing synchronous generators are required to generate or supply reactive power so that the generating facility does not impose any additional reactive power demand upon SCE other than the demand of loads within the facility. The Producer will not be permitted to deliver excess reactive power to SCE under normal operating conditions unless otherwise agreed to by SCE. Under emergency operating conditions, the Producer is permitted to deliver excess reactive power to SCE to ensure voltage schedule compliance.

Producers connected to the subtransmission system or bulk power system (above 34.5 kV) must have the voltage regulation equipment and generator reactive power capability to maintain a voltage schedule or reactive power schedule prescribed by SCE or, if applicable, the CAISO. Generators must be capable of operation over the power factor ranges designated in Table 5.5.

## **5.8.3 Reactive Power Supply Requirements - Inverter Systems**

### ***Applicable to Generation Facilities***

Forced-commutated inverters must meet SCE's reactive power supply Requirements of synchronous generators in 5.8.2. Line commutated inverters must be corrected to satisfy SCE's reactive power supply Requirements of induction generators in 5.8.1.

Inverters must also meet SCE's harmonic load limits based on IEEE Standard 519-1992. For further information on the assessment and mitigation of harmonics due to inverters, refer to "SCE Transmission Planning Criteria and Guidelines, Appendix F, HARMONIC LOAD LIMITS, APPLICATION OF IEEE STANDARD 519-1992 TO TRANSMISSION AND SUBTRANSMISSION PLANNING".

### **5.8.3.1 IEEE and UL Standards for Inverter Systems 200 kVA or Less**

#### ***Applicable to Generation Facilities***

Inverter systems which conform to the recommended practices in IEEE Standard 929-19 and which have been tested and approved for conformance to UL Subject 1741, are considered to have met all SCE's reactive power supply Requirements.

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## **5.8.4 Voltage and Reactive Control**

### **5.8.4.1 Coordination**

#### *Applicable to Generation, Transmission, and End-User Facilities*

Operating entities shall coordinate the use of voltage control equipment to maintain transmission voltages and reactive flows at optimum levels for system stability within the operating range of electrical equipment. Operating strategies for distribution capacitors and other reactive control equipment shall be coordinated with transmission system requirements.

### **5.8.4.2 Transmission Lines**

#### *Applicable to Transmission Facilities*

Although transmission lines should be kept in service as much as possible, during over-voltage system conditions a customer's transmission line(s) may be subject to removal from operation as a means to mitigate voltage problems in the local area. SCE will notify CAISO when removing such facilities from and returning them back to service.

### **5.8.4.3 Switchable Devices**

#### *Applicable to Transmission and End-User Facilities*

Devices frequently switched to regulate transmission voltage and reactive flow shall be switchable without de-energizing other facilities.

## **5.9 Off-Nominal Frequency Requirements**

### *Applicable to Generation Facilities*

Producer generating facilities that protect for off-nominal frequency operation should have relaying protection and generating equipment that accommodates, at a minimum, under frequency and over frequency operation for the following specified time frames in the table below.

**Table 5.6: WECC Off Nominal Frequency Limits**

<b>Under Frequency Limit</b>	<b>Over Frequency Limit</b>	<b>Minimum Time</b>
> 59.4 Hz	60.0 to < 60.6 Hz	continuous operating range
≤ 59.4 Hz	≥ 60.6 Hz	3 minutes
≤ 58.4 Hz	≥ 61.6 Hz	30 seconds
≤ 57.8 Hz	N/A	7.5 seconds
≤ 57.3 Hz	N/A	45 cycles
≤ 57.0 Hz	> 61.7 Hz	instantaneous trip

Frequency relay settings must not allow less stringent operation of the generating facility than specified in the WECC Off Nominal Generation Requirements shown in Table 5.6, unless agreed to in writing by SCE and coordinated with SCE's abnormal frequency operation plan. It is the Producer's responsibility to ensure conformance with the latest approved WECC Off Nominal Generation Requirements.

The CAISO is responsible for frequency control and therefore SCE can assume no responsibility for damage that occurs due to off nominal frequency operation. It is possible that the electrical network including SCE's system may operate outside of the limits stated above. It is the responsibility of all Producers connected to SCE's electrical system to install equipment to protect against damage to Producer owned equipment from off-nominal frequency operation.

Generators that are required to use under-frequency detection for islanding must coordinate frequency threshold settings to ensure conformance with SCE's abnormal frequency operation plan. In general, detection and separation of generators under islanded conditions take precedence over sustained operation of these particular generators through system frequency deviation events.

## **5.10 Voltage Imbalance and Abnormal Voltage or Current Waveforms (harmonics)**

### ***Applicable to Generation Facilities, Transmission, and End-User Facilities***

Power quality problems are caused when voltage imbalances and harmonic currents result in abnormal voltage and/or current waveforms. Generally, if an INTFAC's output degrades power quality to SCE's customers' facilities, other INTFACs, or SCE's facilities, SCE may require the facility to install equipment to eliminate the power quality problem.

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### **5.10.1 Voltage Imbalance**

#### ***Applicable to Generation, Transmission, and End-User Facilities***

The unbalanced voltage level (magnitude and phase), due to the INTFAC to be connected at the transmission or subtransmission system level, may not exceed 1% at the Point of Common Connection<sup>4</sup> (PCC), under steady state system conditions. Under certain conditions (contingency conditions), SCE may allow higher levels of voltage imbalance if justified after a study conducted by SCE. In any event, the unbalanced voltage level created by an INTFAC shall not exceed 1.5%.

It is the responsibility of INTFACs, connected to the SCE electrical system, to install the adequate mitigation devices to protect their own equipment from damage that maybe caused by voltage imbalance condition.

### **5.10.2 Harmonics**

#### ***Applicable to Generation, Transmission, and End-User Facilities***

INTFACs are required to limit harmonic voltage and current distortion produced by static power converters or similar equipment in accordance to good engineering practice used at their facility to comply with the limits set by the current IEEE Standards.

### **5.10.3 Disconnection**

#### ***Applicable to Generation, Transmission, and End-User Facilities***

SCE may disconnect any INTFAC until the above Requirements are met.

### **5.10.4 Photovoltaic Inverter Systems**

#### ***Applicable to Generation, Transmission, and End-User Facilities***

Photovoltaic inverter systems which conform to the recommended practices in IEEE Standard 929-1999 and which have been tested and approved for conformance to UL Subject 1741 are considered to have met SCE's Requirements for voltage imbalance and abnormal waveforms.

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<sup>4</sup> The PCC will generally be at the location of the revenue meter or the point of ownership change in the electrical system between SCE and the Producer. For customers served by dedicated facilities, the location of the PCC will be determined by mutual agreement between the Producer and SCE.

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## 5.11 Switching and Tagging Rules

### *Applicable to Generation Facilities*

SCE and Producer shall provide the other Party a copy of its switching and tagging rules that are applicable to the other Party's activities. In accordance with SCE's switching and tagging rules to ensure the safety of SCE's personnel, the Producer shall allow SCE to place its locks on the Producer's Interconnection Facilities (specifically disconnect switches and/or circuit breakers on the Producer's terminus of the Producer's generation tie line) to prevent inadvertent energization of the Producer's generation tie line while SCE personnel are performing maintenance and/or repair work on SCE's Interconnection Facilities, as may be required.

The Producer's substation facilities must incorporate a 3 phase gang operated disconnect with a common operating handle for 230 kV and below; 500 kV shall require a disconnect operating handle for each phase. The disconnect shall be placed in the LINE DISCONNECT position on the high side of the Producer's generation tie line. The operating handle of the disconnect/disconnects must include a provision for locking the disconnect control handle/handles in the open positions. The locking feature may be utilized by either party when inter-company clearances are issued on the Producer's generation tie line.

The Producer's substation facilities must incorporate a 3 phase gang operated GROUND disconnect with a common operating handle for 230 kV and below; 500 kV shall require a GROUND disconnect operating handle for each phase. The disconnect shall be placed in the line position on the high side of the Producer's generation tie line. The operating handle of the disconnect/disconnects must include a provision for locking the disconnect control handle/handles in the closed positions. The locking feature may be utilized by either party when inter-company clearances are issued on the Producer's generation tie line.

### **5.11.1 Manual Disconnects**

#### *Applicable to Generation Facilities*

The producer shall furnish and install a ganged, manually-operated isolating switch near the point of Interconnection to isolate the Generation Facility from the SCE's Electric System.

The device must:

1. Allow visible verification that separation has been accomplished.
2. Include marking or signage that clearly indicates open and closed positions.
3. Be capable of being reached quickly and conveniently 24 hours a day by SCE personnel.

4. Be capable of being locked in the open position.
5. Be clearly labeled with permanent signage.

## **5.12 Grounding Circuits and Substations**

### **5.12.1 Nominal Voltage and Grounding**

#### *Applicable to Generation, Transmission, and End-User Facilities*

SCE's most common primary distribution voltages are 4, 12 and 16 kV depending on the geographic area. Other voltages are also used in specific areas. Subtransmission voltages are nominally 66 kV to 115 kV. Transmission system voltages are nominally 161 kV, 220 kV and 500 kV. The majority of the 4, 12, and 16 kV circuits are effectively grounded, but some are operated with high impedance grounding. A substantial number of the effectively grounded circuits are used for four-wire distribution (phase to neutral connected loads). SCE will provide the INTFAC necessary information on the specific circuit serving the INTFAC for proper grounding.

### **5.12.2 Ground Mats**

#### *Applicable to Generation, Transmission, and End-User Facilities*

If the INTFAC and SCE substation ground mats are tied together, all cables may be landed without any protection. If the INTFAC and SCE substation ground mats are not tied together, all cables shall have protection at both ends. The design of cable protection, if any, on circuits used for protective relaying purposes shall be such that the operation of the protective relaying is not hampered when the cable protection operates or fails.

All INTFAC ground mats shall be designed in accordance with good engineering practice and judgment. Presently the recognized standard for grounding is IEEE 80 "IEEE Guide For Safety in AC Substation Grounding." All ground mat designs should meet or exceed the requirements listed in this standard. If local governmental requirements are more stringent, building codes for example, they shall prevail. All INTFACs shall perform appropriate tests, including soil resistivity tests, to demonstrate that their ground grid design meets the standard. Mats shall be tested at regular intervals to ensure their effectiveness.

Grounding studies shall be performed with industry recognized software to determine if INTFAC and SCE ground grids should be separate or tied together. This study will determine the maximum safe fault current for the ground grid design. It is suggested that the grid be designed for the maximum fault currents expected over the life of the facility.

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If for any reason the worst-case fault current exceeds the design maximum fault current value due to changes in the producer's facility or changes on the SCE system, the INTFAC shall conduct new grounding studies. Any changes required to meet safety limits and protect equipment shall be borne by the INTFAC.

The INTFAC is responsible to ensure that the GPR (Ground Potential Rise) of the Producer's or interconnected mat does not negatively affect nearby structures or buildings. The cost of mitigation for GPR and other grounding problems shall be borne by the INTFAC. If it is elected to install separate ground grids for SCE and the INTFAC, the facility shall be responsible to mitigate any transfer voltages and GPR that occur to SCE's grid due to faults on the INTFACs.

Any ground grid design, which results in a GPR that exceeds 3,000 volts RMS for the worst-case fault or has a calculated or measured ground grid resistance in excess of 1 ohm, will require special approval by SCE.

### **5.12.3 Substation Grounding**

#### ***Applicable to Generation, Transmission, and End-User Facilities***

The INTFAC shall follow practices outlined in IEEE 80 "IEEE Guide for Safety in AC Substation Grounding." Substation grounding is necessary to protect personnel and property against dangerous potentials and currents during both normal and abnormal conditions of operation. Also, it provides a path to ground for the discharge of lightning strikes, a path to ground for the neutral currents of grounded neutral circuits and apparatus, the facilities for relaying to clear ground faults, the stability of circuit potentials with respect to ground and a means of discharging current-carrying parts to be handled by personnel.

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## Section 6: Revenue Metering Requirements

### *Applicable to Generation and End-User Facilities*

#### **6.1 General Information**

Revenue metering is required to measure the energy and capacity delivered and consumed by a Producer's station load. While functionally similar, there are varying Requirements for Producers depending on the nature and purpose of their generating facility and varying rules established by the authorities having jurisdiction over a Producer and SCE. Metering Requirements for Producers taking service under a FERC tariff, and retail service under CPUC regulations are set forth in Section 6.2.

In general, all ISO revenue metering and associated equipment used to measure a generator's energy, and capacity output, shall be provided, owned, and maintained at the Producer's expense.

##### **6.1.1 Retail Service**

The retail metering requirements for retail service will be owned, operated, and maintained by SCE under SCE's [Electrical Service Requirements](#) (ESR) and in accordance with SCE approved tariffs.

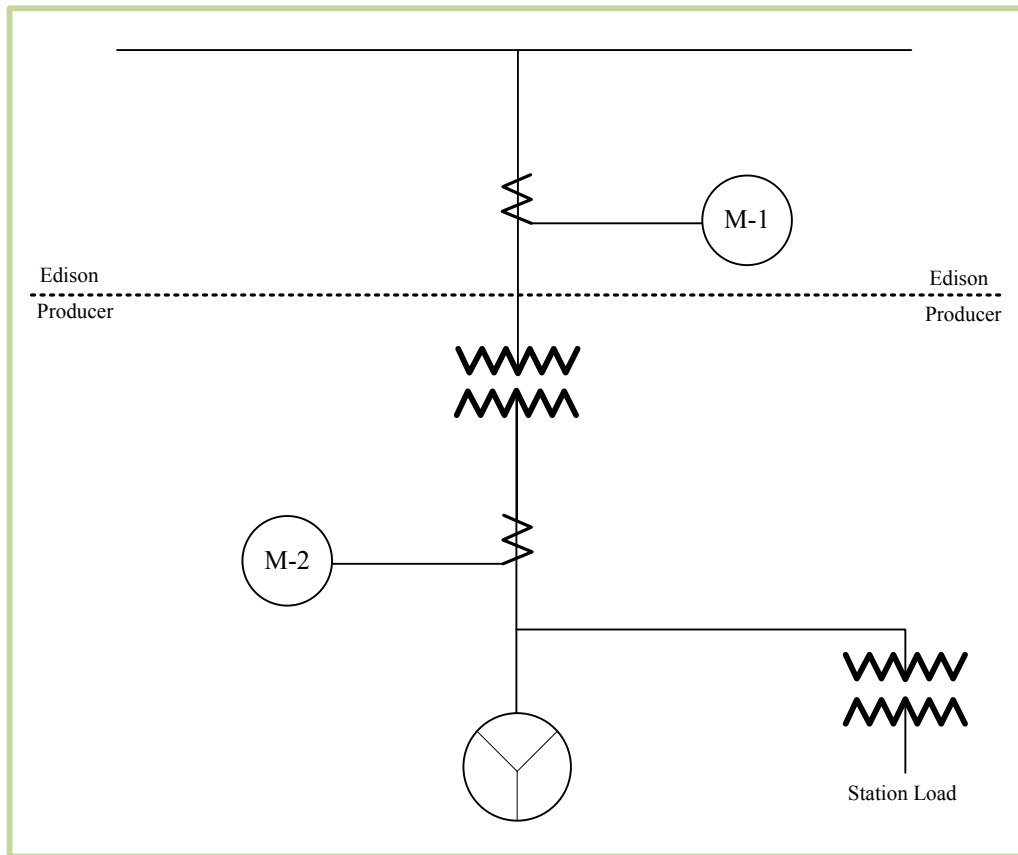
#### **6.2 Revenue Metering Requirements for Generators**

##### **6.2.1 General Information**

In order to measure energy and capacity delivered and scheduled with the CAISO, a Producer shall install all necessary meters, routers, telecommunications, and associated equipment to comply with the metering standards and requirements of the CAISO Tariff and Metering Protocol. As required by the CAISO Tariff, a Producer's metering facilities shall be certified by the CAISO. Further, retail service will be measured using an SCE owned meter including SCE owned metering PT's and CT's. However, a producer may install the required ISO metering in tandem with the SCE owned metering. Figure 6a shows a typical SCE metering installation for a generating facility without departing load and Figure 6b also shows a typical CAISO customer owned meter and SCE owned meter in tandem on the customers side of the fence and an SCE metering installation for SCE retail billing purposes on SCE property of a generating facility with departing load.

### Figure 6a: Typical Metering Installation for a Generating Facility

Typical metering configuration for Generators taking service under the CAISO Tariff without CAISO metering installed on Producer's side of the interconnection with no departing load showing placement of SCE metering at M-1 or M-2, respectively.



M1 – SCE Billing Meter  
M2 – SCE Billing Meter in an ESR Compliant Meter Cubicle

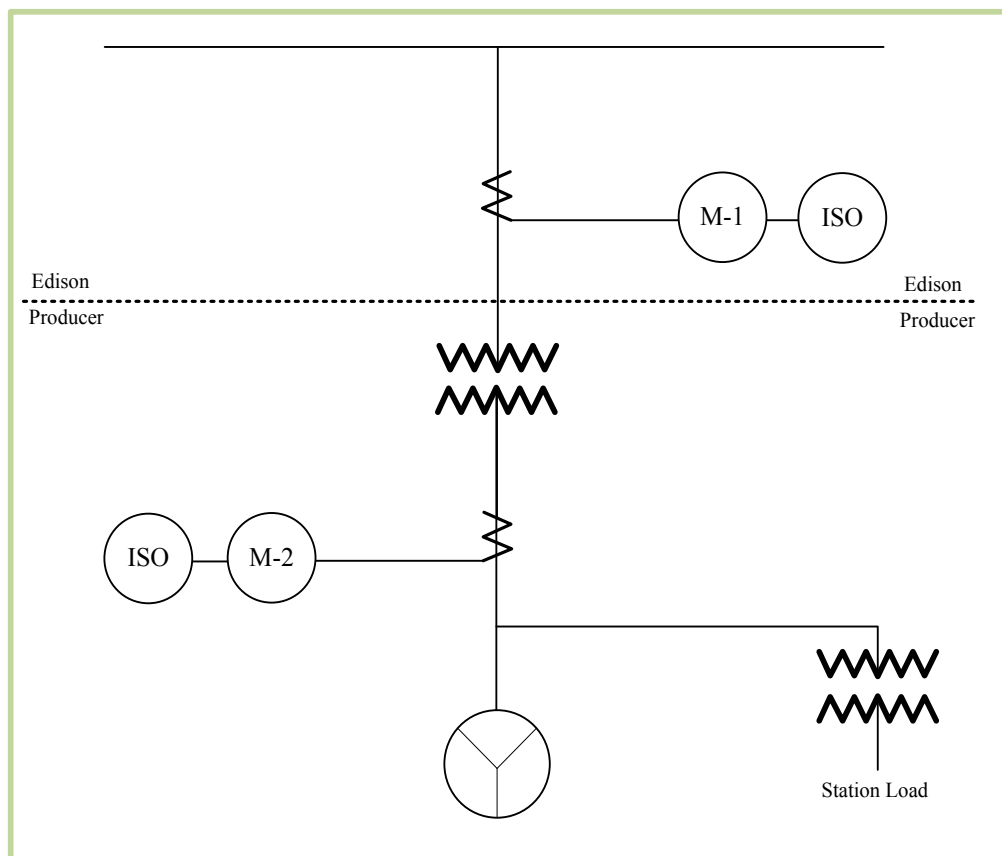
## 6.2.2 Location/Ownership of CAISO Metering Equipment

### *Applicable to Metering Installed on a Producer's Side of Interconnection*

A Producer shall, at its expense, install, own, and maintain all CAISO metering equipment, including metering CTs/PTs, meters, routers, and telecommunication's equipment providing such equipment is installed on its assets and located on its side of the point of interconnection with SCE (Figure 6b)

**Figure 6b: Location/Ownership of CAISO Metering Equipment for a Generating Facility**

Typical metering configuration for Generators taking service under the CAISO Tariff with CAISO metering installed on Producer's side of the interconnection with no departing load showing placement of SCE metering at M-1 or M-2, respectively.



M1 – SCE Billing Meter

M2 – SCE Billing Meter in an ESR Compliant Meter Cubicle

If a Producer elects Direct Access service pursuant to SCE's Rule 22, it must comply with Rule 22 metering requirements for retail billing.

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## Section 7: Telemetry Requirements (Hardware)

### 7.1 Telemetry Requirements

#### *Applicable to Generation, Transmission, and End-User Facilities*

For a high degree of service reliability under normal and emergency operation, it is essential that the INTFAC have adequate and reliable telecommunication facilities.

The INTFAC shall specify the following at the point of connection: the requested voltage level, MW/MVAR capacity, and/or demand.

#### *Applicable to Generation Facilities*

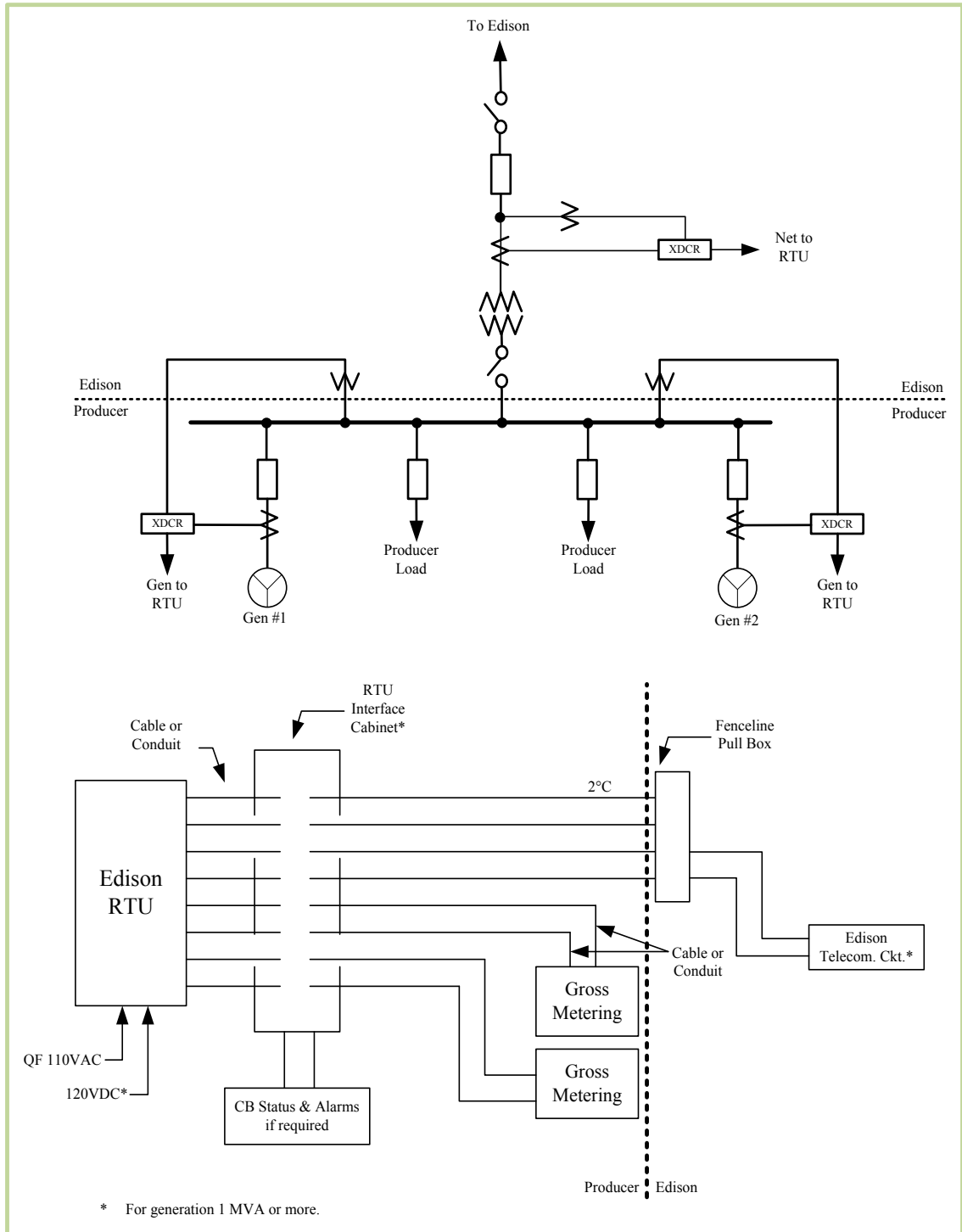
Producers with generating facilities 1 MVA nameplate<sup>5</sup> or larger will require telemetry equipment and telecommunications at Producer's expense. For projects equal to or greater than 1 MVA but less than 10 MVA, real time SCADA telemetry of watts and vars only are required for total generation and customer load. For projects greater than 10 MVA, the telemetry equipment must transmit at minimum generator unit gross MW and MVAR, generator status, generator circuit breaker status, and generator terminal voltage. In addition, real time telemetry of project net MW and MVAR is required.

(Refer to the following Figure 7). Wind generation facilities equal to or greater than 1MVA nameplate will require real-time monitoring in most cases. It is the Producer's responsibility to comply with any CAISO telemetry requirements. These telemetry requirements apply to non-exporting-for-sale as well as exporting-for-sale generating facilities; refer to SCE System Operating Bulletin 510 for exemptions to certain non-exporting-for-sale generating facilities.

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<sup>5</sup> For inverter based technology generator projects, the Gross Nameplate Rating is the AC nameplate rating of the inverter units.

**Figure 7: Typical Remote Terminal Unit (RTU) Installation  
1 MVA Nameplate OR MORE Generating Facility**



\* For generation 1 MVA or more.

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## 7.2 Total Generation 1 MVA Nameplate or More

### *Applicable to Generation Facilities*

The following is a list of Requirements for the installation of a Real-Time Remote Terminal Unit (RTU) or equivalent device at the Producer's generating facility. Unless otherwise specified, all the facilities listed below are to be provided by the Producer.

The typical RTU utilized by SCE is the DAQ Callisto RTU, GE-Harris D20, or equivalent.

The size and point count of the RTU is determined based on the generation nameplate capacity as well as the number of data points to be monitored. SCE will install, own, operate, maintain, repair, inspect, use, control, alter, replace and upgrade the RTU.

### **7.2.1 The following specifications are to be used as informational guidelines to facilitate the RTU installation at the Generation Facility:**

- a) An interior location suitable for floor or wall mounting the RTU cabinet is required. The location should be reasonably close to the origin of telemetering signals. A control room or relay house is acceptable as long as the temperature range is within 0C to 70C. Cable access can be either through the top or bottom of the RTU cabinet.
  - Wall space for a single door cabinet 24 inches wide by 20 inches deep by 30 inches high. The wall mount cabinet weighs 125 pounds and is mounted with a ½ inch bolt through mounting tabs at each corner.
  - Floor space for a single door cabinet 30 inches wide by 24 inches deep and 72 inches tall with a minimum of 30 inches of front access for door. The floor-mount cabinets weigh approximately 500 pounds. The floor cabinet is anchored to the floor with four bolts and concrete anchors.
- b) Provide a 120 VAC 15 Amp convenience power source to the RTU cabinet. This source will utilize a dedicated breaker labeled “SCE-RTU”. A 4 foot coil is to be left at the RTU location and will be terminated by SCE inside the RTU cabinet.
- c) Station DC power (48VDC or 125VDC) on a dedicated 5 Amp circuit breaker (not shared with other equipment) run to the RTU cabinet for RTU power. Breaker to be labeled SCE-RTU. If DC power is not available, a 120 VAC circuit may be used as long as this circuit is sourced from an Uninterruptible Power System with a minimum of 4 hour backup.

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- d) One stranded AWG #8 conductor will be connected to station ground and run to the RTU cabinet by the customer.
- e) The customer will run all data signal cables to the RTU cabinet or to a near-by (6 feet or less) interface cabinet for termination. Data cables must be shielded with shield grounded at RTU end only. Twisted-pair stranded wire between AWG#16 and AWG#22 or twisted-pair solid wire between AWG#18 and AWG#24 may be used. 6,12,25 and 32 pair cables are typical. A 10 foot coil is to be left at the RTU location and will be terminated by SCE inside the RTU cabinet.
- f) Data signals will include 2 of the three quantity pairs listed below<sup>6</sup>.
- Gross MWatts and MVars for each unit.
  - Net MWatts and MVars for each unit.
  - Auxiliary MWatts and MVars for each unit.

Data signals will also include:

- KVolts for each unit (terminal voltage).
- Circuit breaker open/closed status for each unit CB.
- Online status for each unit.

All analog quantities will be represented by a + / – 1 milliamp or 4 to 20 milliamp current loop. The current loop may be shared as long as there are no grounds and it is not driven beyond the manufacturers specified limits. Circuit breaker and unit on/off line status will be represented by a dry contact available at the interface cabinet. All status points will utilize the Normally Open contacts of the customer provided isolation relay. The RTU will provide the contact wetting voltage.

SCE's Grid Control Center (GCC) on a site-to-site basis may deem other status, protection alarms, or controls necessary.

- g) Two communication methods are supported to connect the RTU to the SCE's EMS Remote Port Servers at one of SCE's Substations.
- Dedicated 3002-type voice grade 4-wire communications circuit. SCE's IT Infrastructure group will provide coordination for the installation of landline communications facilities.

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<sup>6</sup> For project equal to or greater than 1 MVA but less than 10 MVA, real time SCADA telemetry of watts and vars only are required for total generation and customer load.

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- SCE satellite communications package may be provided if a landline circuit is not feasible. A suitable location for the satellite antenna is any wall or pole that provides an unobstructed view of the sky directed to 130 degrees (South-East) with an angle to the horizon of 40 degrees. The customer must run a ¾ -inch or 1-in conduit from the RTU to within 24 inches of the satellite antenna for the communications and antenna power cables. A weather head is required at the antenna end of the conduit. Currently, Satellite Communication method is **not available** and to be revised at a later date due to design issues with hub capacity and data protocol.
  - h) The RTU cabinet can be delivered to the customer premises for mounting and conveniences to the customer.
  - i) 24-hour access to the RTU for maintenance by SCE's Power System Controls technicians.
  - j) Ground Mats

See Section 5.12.2: Ground Mats.

### **7.3 Exemption for Cold-Iron and Emergency-Backup Generators**

**Note:** These types of generators are not operated in parallel to the SCE electrical system except for short times (*typically only several minutes*) while performing a “soft-transfer” of customer load between the generator and SCE's electrical system. As such, the telemetry requirements of this section **do not apply** to Cold-Iron or Emergency-Backup generators.

#### **7.3.1 Cold-Ironing is the action of providing shore-side electrical power to a ship at berth while its on-board generator(s) are shut down.**

- a) Cold-Iron generator is a generator on board a ship which has the capability of Cold-Ironing.
- b) The initial process of Cold-Ironing involves paralleling the ship's electrical system to the SCE electrical system for a short duration while the ship's electrical load is transferred between the ship's generator and shore power. A Cold-Iron generator does not parallel to the SCE electrical system beyond the initial transferring process.

#### **7.3.2 Emergency-Backup Generation (EBG) is customer-owned generation utilized when disruption of utility power has occurred or is imminent.**

- a) When utilized, **following** a disruption, the customer would first disconnect from SCE's electrical system prior to starting up the EBG.

- 
- b) B. When utilized **prior to** a disruption of utility power, the EBG would be started and loaded to carry the entire customer load, and then the customer would disconnect from SCE's electrical system.
  - c) C. Upon resumption of utility power, the customer would first connect to SCE's electrical system and then unload the EBG.

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## **Section 8: Telecommunications Requirements**

### **8.1 General Description**

The following requirements are to be used as informational guidelines to facilitate a typical Telecommunications equipment installation at an INTFAC.

SCE will determine the line protection communication requirements for the INTFAC gen-tie. If communications paths via diverse routing are required, OPGW (fiber Optical Ground Wire) on the gen-tie may serve as one path. If SCE later determines the INTFAC is part of a SPS, diverse routing of communication paths will be required.

If communications are required for line protection or a SPS, and Telemetry (SCADA), communications will be provided via the fiber optics. If line protection or SPS is not required, leased 3<sup>rd</sup> party circuits may be used for telemetry (SCADA). SCE shall design, operate, and maintain certain telecommunications terminal equipment at the INTFAC to support Telemetry (SCADA), equipment protection, and SPS communications applicable to the project.

Note:

While SCE may discuss telecommunication connection preferences of the INTFAC, SCE is solely responsible for their selection, as it must fit within the operating requirements, design parameters, and communications network architecture of the entire SCE telecommunications network.

In addition, microwave as an option for the second diverse communications route to support protection of the gen-tie will only be estimated after agreement with INTFAC. Use of microwave on the network, including as part of Network Upgrades, will be at SCE's sole discretion.

### **8.2 Space Requirements**

The INTFAC shall provide sufficient floor space within a secure building for SCE to install and operate up to two 8' x 19" wide communication equipment (EIA-310-D) racks. These racks shall contain telecommunication equipment to support SCADA, equipment protection, and SPS communications applicable to the project. SCE recommends separating the communications equipment into two racks when diverse protection and/or SPS circuits are required.

The INTFAC shall provide sufficient wall space adjacent to the SCE communication equipment rack(s) for a 36" x 36" x 3/4" plywood backboard for leased or other related circuit termination. The plywood shall be clear of obstructions from adjacent equipment and painted with fire resistant gray semi-gloss enamel (Dunn-Edwards DE-1073, New Hope Gray or equivalent).

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The INTFAC shall provide a working clearance of 49.5 inches (measured from the center of the rack) in front and behind the equipment rack(s) for the safety of installation and maintenance personnel. The working clearance specified provides a 36” unobstructed space for ladders and/or test equipment carts. Additionally, SCE considers telecommunications equipment racks to contain “live electrical equipment,” which is consistent with the 36” working clearance specified in the National Electric Code.

SCE shall secure the equipment rack using the floor angles using only with ½”-13 stainless steel hardware. If the floor of the equipment room is concrete, Hilti HDI 1/2 “drop-in” anchors shall be used.

### **8.3 HVAC Requirements**

The INTFAC shall provide and maintain suitable environmental controls in the equipment room, including an HVAC system to minimize dust, maintain a temperature of 30° C or less, and 5-95% non-condensing relative humidity. NOTE: Environmental controls for microwave terminal equipment are generally more stringent than fiber optic terminal equipment.

### **8.4 Power And Grounding Requirements**

The INTFAC shall provide a connection point to station ground within ten (10) feet of the SCE communication equipment rack(s). SCE will provide and install cabling from the equipment rack(s) to the designated station ground termination to protect the communications equipment and service personnel.

The INTFAC shall provide two 10 Amp dedicated branch circuits from the 125VDC station power to support the telecommunications equipment rack(s). The dedicated source breakers shall be labeled “SCE-Telecom A” and “SCE-Telecom B.” If DC power is not available, two 15 amp 120 VAC circuits may be used as long as the circuits are sourced from an Uninterruptible Power System with a minimum of 4 hour backup. The power source shall not be shared with other equipment.

Note: The following are the RTU power requirements (from Section 7.2.1.b &c) and differ from the Telecom Power and Grounding Requirements.

- 7.2.1.b** Provide a 120 VAC 15 Amp convenience power source to the RTU cabinet. This source will utilize a dedicated breaker labeled “SCE-RTU”. A 4 foot coil is to be left at the RTU location and will be terminated by SCE inside the RTU cabinet.

- 
- 7.2.1.c** Station DC power (48VDC or 125VDC) on a dedicated 5 Amp circuit breaker (not shared with other equipment) run to the RTU cabinet for RTU power. Breaker is to be labeled SCE-RTU. If DC power is not available, a 120 VAC circuit may be used as long as this circuit is sourced from an Uninterruptible Power System with a minimum of 4 hour backup.

Additionally, the INTFAC shall provide a 120 VAC 15 Amp convenience power source adjacent to the telecommunications equipment rack(s). As this source will be utilized for tools and test equipment by installation and maintenance personnel, UPS is not required. The INTFAC shall provide ample lighting for the safety of installation and maintenance personnel.

## **8.5 Miscellaneous**

For projects requiring only a leased 3<sup>rd</sup> party circuit for RTU communications, the INTFAC shall provide conduit, raceway, copper cable, fiber optic cable as necessary for SCE to extend the leased circuit from the Local Exchange Carrier MPOE (Minimum Point of Entry or “demark”) to the SCE communications equipment rack(s). The SCE equipment rack(s) shall be no more than 100’ from the MPOE.

The monthly cost of the leased 3<sup>rd</sup> party circuit shall be the responsibility of the INTFAC. To comply with WECC guidelines, dual fiber optic cables via diverse routing will be used for, line protection and/or SPS communications. If provided by the INTFAC for its gen-tie, it shall extend fiber optic strands to the SCE communications equipment rack. If either of the fiber optic cables is provided by SCE for the gen-tie, SCE will collaborate with the INTFAC to support design and construction of fiber optic cable to the INTFAC.

If the SCE RTU is not located within the same facility, the INTFAC shall provide conduit, raceway, copper cable, fiber optic cable as necessary for SCE to extend the Energy Management System RTU circuit from the communications equipment to the RTU or from a 3<sup>rd</sup> party communications circuit. The SCE RTU and communications equipment rack(s) shall be no further apart than 100’. If applicable, the INTFAC shall provide fiber optic cabling as necessary to extend all required circuits from the communications equipment to the line protection and SPS relays.

## **8.6 ACCESS REQUIREMENTS**

After the communication equipment is installed and in operation, the INTFAC shall provide 7x24 access to SCE employees and approved contractors for planned maintenance and service restoration.

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## Section 9: Property Requirements

### 9.1 Right of Way Requirements

#### *Applicable to Generation, Transmission, and End-User Facilities*

The INTFAC must acquire the necessary Rights of Way requirements for their gen-tie or transmission line, along with the Access requirements to the point of interconnection with SCE's facilities. The use of SCE Rights of Ways and/or property shall not be included in any interconnection proposals.

### 9.2 Transmission Line Crossing Policy

#### *Applicable to Generation, Transmission, and End-User Facilities*

The Interconnection Transmission line or Access Rights of Way that are proposed to cross SCE Transmission line or Access easements or fee owned property must be submitted to SCE Real Properties organization for a separate review request and approval. For your reference, below are SCE's Transmission Crossing Policy guidelines:

- A new INTFAC transmission line of equal or lower voltage shall not be allowed the superior position and will cross under the existing SCE Facilities and/or the new facilities proposed prior to the new line, including facilities needed for queued-or-clustered--ahead generation.
- A new INTFAC transmission line, triggered by an INTFAC, with higher voltage may be allowed the superior position with G.O. 95<sup>7</sup> Grade "A" self-supporting Dead-end construction with minimum of double insulator strings on both sides. This will apply to all voltages. SCE will regain the superior position should SCE lower voltage facilities be upgraded in the future of equal or higher voltage than the INTFAC.
- A new INTFAC transmission line of higher voltage may be allowed the superior position if it is crossing a SCE multiple circuits corridor (two circuits or more), but this type of crossing will need to be reviewed on a case by case basis.
- A new INTFAC transmission line, regardless of voltage, shall not be allowed the superior position if it is crossing a circuit which terminates at the switchyard for a nuclear power plant.

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<sup>7</sup> **General Order No. 95. (G.O. 95)** the "Rules for Overhead Line Construction" established by the California Public Utilities Commission is minimum requirements for designing and constructing overhead and underground electrical facilities. In some cases SCE Practices and Standards may be more stringent. The INTFAC must adhere to the appropriate requirements.

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### 9.3 Infrastructure Property Requirements

#### *Applicable to Generation, Transmission, and End-User Facilities*

Substation: The following approximate land requirements are needed for typical interconnection facilities (SCE owned substation) on the customer's property:

- 66kV Tap: 90 ft by 110 ft
- 66kV Loop: 110 ft by 150 ft
- 115kV Tap: 100 ft by 120 ft
- 115kV Loop: 120 ft by 180 ft
- 220kV Loop: 290 ft by 480 ft
- 500kV Loop: 420 ft by 780 ft

Minimum substation land requirements are subject to change according to engineering studies and interaction with SCE is required for final determination. The dimensions above include a required 10 ft. easement bordering the interconnection facility under the assumption that the customer owns the transformer and the land needed for the incoming line(s) is not included.

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**Revision History Table:**

Revision	Date	Comments
1	11/3/04	Document Created
2	03/19/09	Revised to incorporate interconnection requirements for new Generation, Transmission, and End User facilities.
3	10/2/09	Revised to incorporate the new wind-turbines set-back criteria.
4	08/02/10	Revised to incorporate the Transmission Line Crossing Policy.
5	10/5/11	Revised to include new Section 8 – Telecommunications Requirements. Updated the following Sections 3 – Protection Requirements, Section 4.15.2 – Removal of C-RAS reference, and Section 7 – Telemetry Exemptions and 1MW size clarification.

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## **Appendix A**

Following is a list of the technical standards and criteria referenced within SCE's Interconnection Technical Requirements.

NERC/WECC Planning Standards

WECC Coordinated Off-Nominal Frequency Load Shedding and Restoration Plan

CAISO Large Generator Interconnection Procedures, in response to FERC Order No. 2003

IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems

IEEE 80 Guide for Safety in AC Substation Grounding

IEEE 929 Recommended Practice for Utility Interface of Residential and Intermediate Photovoltaic (PV) Systems

IEEE 519 IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems

IEEE C37.010-1999 IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

UL 1741 Inverters, Converters, and Controllers for Use in Independent Power Systems

ANSI C84.1 Voltage Ratings for Electric Power Systems and Equipment

SCE Transmission Planning Criteria and Guidelines

WECC Minimum Operating Reliability Criteria

Overview of Policies and Procedures for Regional Planning Project Review, Project Rating Review, and Progress Reports

<b><i>Transmission &amp; Distribution Business Unit, Transmission &amp; Interconnection Planning</i></b>	<b>NERC Reliability Compliance Program</b>	Document No.	1
		Version No.	5
<b>INTERCONNECTION HANDBOOK</b>		Effective Date	10/5/11

### Next Review Date

This document shall be reviewed upon a change in the referenced documents that may impact this document.

### Data Retention

This document shall be retained a minimum of 4 years from last WECC on-site audit and is stored in/on the Reliability Standards and Compliance Group document library.

### Approval

<b>TDBU Business Line</b>	<b>Signature</b>	<b>Date</b>
Transmission & Interconnection Planning	Original Copy signed by Dana Cabbell	11/10/11

### Revision History

<b>Rev. No.</b>	<b>Date</b>	<b>Description of Revision</b>	<b>By</b>	<b>Next Review Date</b>
1	03/19/09	Revised the Interconnection Handbook, Generators to incorporate interconnection requirements for new Generation, Transmission, and End User facilities	---	---
2	03/19/09	Replaces all remaining referenced documents in Version 1, so that, this Interconnection Handbook will be used for new Generation, Transmission, and End User facilities	---	---

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<b><i>Transmission &amp; Distribution Business Unit, Transmission &amp; Interconnection Planning</i></b>	<b>NERC Reliability Compliance Program</b>	Document No.	1
		Version No.	5
<b>INTERCONNECTION HANDBOOK</b>		Effective Date	10/5/11

<b>Rev. No.</b>	<b>Date</b>	<b>Description of Revision</b>	<b>By</b>	<b>Next Review Date</b>
3	10/02/09	Revised to incorporate new SCE approved wind turbines set-back criteria.	---	---
4	08/02/10	Incorporated the new SCE approved Transmission Line Crossing Policy. This update resulted in a reconfiguration of Section 9 and added an additional page to the document.	----	----
5	10/5/11	Sec# 3: Incorporated new diagrams for inverter based interconnections. Incorporated Third Party Protection Equipment Maintenance Responsibility Statement. Sec# 4.15.2: Removal of C-RAS reference from section. Sec# 7: Incorporated exemption of telemetry requirements for Cold Ironing Ships and Emergency back-up generators. And clarification of 1 MVA size definition. Sec# 8: Describe the necessary telecommunications requirements.	----	----

## **Attachments**

None

## **Distribution**

Transmission and Interconnection Planning

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