Valley Electric Association, Inc.

A Touchstone Energy® Cooperative

GRIDLIANCE

Blackstone Portfolio Company

Generation Interconnection Handbook

Applicable to Generators Interconnecting with VEA & GridLiance Transmission Facilities

Notice: Document Subject to Change

The information and requirements in this manual are subject to change over time. The most current version of this Generation Interconnection Handbook is available by emailing your request to VEAengineering@vea.coop.

Effective January 1, 2019

VERSION HISTORY

Version	Date	Action	Change Tracking
1.0	12-29-17	New GI Handbook	New
1.1	1-4-18	Added section describing - Under-Frequency Operating Requirements (PRC-024-2)	New Section 10.10.1
1.2	1-1-2019	Review and update	Updated VEA's contact email; errata

1. GENERATION INTERCONNECTION OVERVIEW

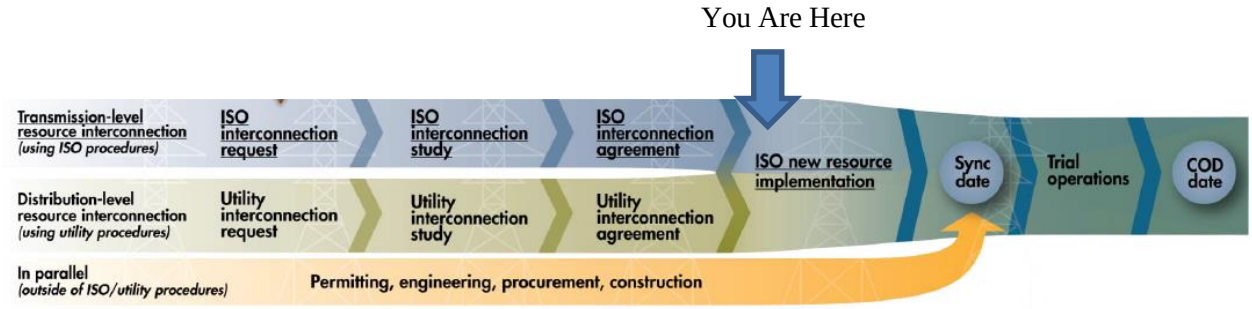
The purpose of this Generation Interconnection Handbook (Handbook) is to provide Customers general requirements to interconnect their non-VEA owned transmission facilities to VEA's electric system. The Handbook describes general requirements. Not all requirements can be specified in a Handbook because some requirements are case specific. Therefore, this Handbook provides Customers an overview of the requirements to address their transmission facility interconnection requests. VEA will determine all interconnection requirements with specificity, thru VEA's interconnection studies requested and paid for by the Customer.

2. INTRODUCTION

This Interconnection Handbook has been prepared by Valley Electric Association, Inc. to identify the typical minimum technical requirements (the "Requirements") for connecting generation facilities to the transmission system operated by Valley Electric Association, Inc. (the "System or Utility"). "VEA" will refer to both Valley Electric Transmission Association, Inc (VETA) and Gridliance West, LLC (GridLiance), as the owners of transmission facilities operated and maintained by Valley Electric Association, Inc. "Valley Electric" will mean only Valley Electric Association, Inc. The interconnections include facility additions and modifications to accommodate Customer facilities being connected or planned to be connected to VEA. These Requirements are necessary to ensure the safe and reliable operation of the electric Utility. Documentation of these Requirements also fulfills compliance obligations associated with North American Electric Reliability Corporation (NERC) standard FAC-001.

An Interconnection Handbook is a handbook, developed by the Participating Transmission Owner (PTO). This handbook describes technical and operational requirements for wholesale Customers connected to the PTO's portion of the CAISO Controlled Grid. PTO standards contained in the Interconnection Handbook shall be deemed consistent with Good Utility Practice and Applicable Reliability Criteria.

Normally, Customers are interested in PTO's Interconnection Handbooks when they have reached the "ISO new resource implementation" stage as shown in the graphic below. However, VEA's Interconnection Handbook is available at any stage of the interconnection process by emailing the Manager of Engineering VEAengineering@vea.coop. This handbook is written for those knowledgeable in the electric industry. Definitions of abbreviated terms are not always defined when used, but rather provided at the end of this document for those unfamiliar with industry terms and abbreviations.



2.1 **Exclusions**

These Requirements do not address procedural information related to facility interconnections nor cover all possible technical details. The Requirements are not intended to function as a design specification. The final design of facility connections to the System will be subject to VEA review and approval on a case-by-case basis.

2.2 **Other Requirements**

In addition to compliance with these Requirements, any person seeking to connect generation is responsible for complying with all other interconnection obligations established by contract and applicable rules, tariffs, regulations, standards, and criteria. Such requirements may include the following:

- NERC reliability standards, recommendations and alerts.
- Western Electric Coordinating Council (WECC) reliability standards
- California Independent System Operator (CAISO) criteria
- Federal Energy Regulatory Commission (FERC) regulation
- State and Local jurisdictional requirements

2.3 **Requirements Are Subject to Change**

These Requirements are subject to change. VEA maintains and updates these Requirements as necessary. The Producer shall ensure that they comply with the most recent version of these Requirements. The current version is available upon request at VEAengineering@vea.coop.

2.4 **Costs**

All arrangements for system studies, engineering design, construction, ownership, operations, maintenance, replacement equipment, metering, facility controls, and telecommunications must be set forth in written contract between VEA, the Producer, and if necessary, the CAISO. If additional equipment or replacement equipment is required on the System to accommodate the facility interconnection, VEA will install or modify the equipment at the cost of the Producer. VEA may maintain transmission capacity and operational control of such equipment. Further, as permitted by applicable laws and regulations, VEA reserves the right to participate in the costs of proposed facility expansion plans that may be accommodated through mutually advantageous alternatives which may also provide substantial benefits to regional reliability or transmission transfer capability. Advance funds or deposits are required by VEA and/or the CAISO prior to any studies, system modifications, upgrades, or additions be performed.

2.5 **Transmission Capacity is Not Guaranteed**

A direct interconnection into VEA's System does not guarantee transmission capacity on portions of the VEA transmission system or neighboring systems. Producer capacity rights are determined through the CAISO GIDAP process as described on the CAISO website (www.caiso.com).

3. STUDY AND NOTIFICATION PROCEDURES (FAC-001, R3)

3.1 **Procedures for Coordinated Studies of New or Materially Modified Interconnections and Their Impacts on Affected Systems (FAC-001, R3.1)**

- VEA is a PTO in the CAISO. VEA has placed all of its transmission system facilities under the administration and operation of the CAISO. Generation, transmission, and end-user facilities that are connecting at the transmission-level are required to follow the CAISO procedures for interconnection.
- The CAISO procedures for interconnection are available on the CAISO website (www.caiso.com). These procedures include steps to request a new Facility interconnection or material modification to an existing interconnection, as well as the data required to be submitted to properly study the interconnection.
- VEA participates in the CAISO study process for transmission-level interconnections in the VEA area. The CAISO manages the coordinated study process for new or materially modified existing transmission-level interconnections and their impacts on affected system(s).

3.2 **Procedures for Notifying Those Responsible for the Reliability of Affected System(s) of New or Materially Modified Existing Interconnections (FAC-001, R3.2)**

- VEA participates in the CAISO study process for transmission-level interconnections in the VEA area. The CAISO manages the process for notifying those responsible for the reliability of affected system(s) of new or materially modified existing interconnections.
- Additionally, the CAISO or VEA will notify affected system(s) of new or materially modified existing interconnections through the CAISO interconnection process or directly by VEA.

3.3 Procedures for Confirming with Those Responsible for the Reliability of Affected Systems of New or Materially Modified Transmission Facilities Are Within a Balancing Authority Area's Metered Boundaries (FAC-001, R3.3)

- Responsibility for Identifying Functional Entities
    - The Customer shall identify the entity responsible for the reliability of the new or materially modified Transmission Facilities (i.e., the Customer is responsible for being or identifying a Transmission Owner and a Transmission Operator for its Transmission Facilities).
    - The Customer is also responsible for identifying the Balancing Authority Area in which its Transmission Facilities will reside. VEA is not responsible for finding a Balancing Authority for the Customer's Transmission Facilities.
- Documentation Required
    - The Customer shall make arrangements for its Transmission Facilities to be within the metered boundaries of a Balancing Authority and shall obtain documentation from the Balancing Authority that its Transmission Facilities are located within the boundaries.
        - This documentation may be a letter from a representative of the Balancing Authority or some other document showing completion of processes to place the Transmission Facilities within the Balancing Authority Area.
        - The documentation must be dated and must confirm that the Transmission Facilities are within the boundaries. (I.e., it cannot be acknowledgement of an application or documentation of an incomplete process.)
    - The Customer shall provide (within the documentation or in a separate document) contact information for the Balancing Authority, specifically a representative that can confirm the Customer's Transmission Facilities are within the Balancing Authority Area.
- Submittal & Review
    - The Customer shall provide the documentation to VEA at least 180 days prior to the desired In-Service Date.
    - VEA will review the documentation to ensure that it meets the requirements listed above. VEA will also contact the Balancing Authority representative for confirmation.
    - If the documentation provided is insufficient or confirmation cannot be obtained, VEA will not provide Approval of the In-Service Date until sufficient documentation has been submitted.
    - **Failure to submit sufficient documentation may cause delays for which the Customer is solely responsible.** The Customer is encouraged to submit documentation early and follow up on the approval process to ensure timely completion of the Interconnection process.

4. TELEMETERING REQUIREMENTS FOR GENERATION MONITORING

4.1 Purpose

VEA requires some Producers to maintain operating communications with Valley Electric's Dispatch Center (also called Dispatch). These communications provide VEA operating records and data about the Producer's generating facilities necessary for VEA to reliably operate its electric system. Generally, Producers with generating facility capacity of 1 MW or greater will have these Requirements, but it may be necessary for VEA to receive generating facility records for smaller generation plants. The table shown below illustrates typical required generating facility records and data, but VEA may require Producers to provide additional records than those shown or described in this handbook.

4.2 **Typical data acquisition requirements are shown below.**

Producer Plant Size and Type (gross MW)	**Data Acquisition Requirement**
Total Generation < 1 MW	Generally, no remote telemetry required.
Non-Wind Generation ≥ 1 MW, but < 10 MW	Real-time SCADA telemetry required: Producer data evaluated on a case-by-case basis, but typically: • Watts, VARs, and Voltage
Wind Generation ≥ 1 MW	Real-time SCADA telemetry required: Producer data: • Watts, VARs, Voltage and main CB status
Any Generation ≥ 10 MW	Real-time SCADA telemetry required: • Any two of the following three data points: Total Gross Generation, Producer Load, Net flow to/from utility interface and • Watts, VARs, Amps, Volts (generator bus), main CB status

4.3 **Potential Requirements for New Generation Facilities 1 MW or Greater**

For Generating Facilities 1 MW or greater, the following real-time data may be required to be telemetered to Dispatch, for each generating unit or for the aggregate plant:

- kW
- kVar
- kWh
- generator status
- generator terminal voltage (kV)
- Producer substation breaker status
- individual generating unit breaker status
- PMU data (Phasor Measurement Unit)

4.4 **For New Generation Facilities Less Than 1 MW**

On a case-by-case basis, Valley Electric may require telemetering for generators of less than 1 MW.

4.5 **VEA and CAISO Discretion for Telecommunication Connections**

While VEA may discuss telecommunication connection preferences of the Producer's generation facility, ultimately, VEA's final discretion regarding the selection of telecommunication connection equipment. The telecommunication connection must fit within the operating requirements, design parameters, and communications network architecture of the entire VEA telecommunications network and CAISO requirements.

4.6 **Fiber Optic (FO) Communications Paths:**

The Producer will build the FO paths from the communication room at its end user Facility to the point of interconnection with VEA. The Producer's OPGW or FO may serve as one path. If a diverse route is required, the Producer may elect to install FO cable in an underground conduit to serve as the diverse

route or choose another method. It is recommended that the diverse routing meets the WECC's definition of diverse routes and is required if the communication path is part of a RAS or SPS.

VEA shall design, operate, and maintain certain telecommunications terminal equipment at the point of interconnection to support line protection, telemetering (SCADA), equipment protection, and SPS communications applicable to the project.

Telemetering equipment (usually a dual-ported RTU) shall be located in the metering enclosure at the Producer's expense. Producer is responsible for procuring and maintaining all telecommunication circuits in accordance with VEA requirements.

Real Time Device: The final real-time device or remote intelligent gateway (RIG) database shall be provided to VEA at least thirty (30) calendar days prior to scheduled energization date.

4.7 Space Requirements

The Producer shall provide sufficient floor space within a secure building at the generator facility site for VEA 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. VEA recommends separating the communications equipment into two racks when diverse protection and/or SPS circuits are required.

The Producer shall provide sufficient wall space adjacent to the VEA communication equipment rack(s) for a 36" x 36" x ¾" 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).

The Producer shall provide a working clearance of 49.5" (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, VEA considers telecommunications equipment racks to contain "live electrical equipment," which is consistent with the 36" working clearance specified in the National Electric Code.

4.8 HVAC Requirements

The Producer shall provide and maintain suitable environmental controls in its generator facility equipment room, including an HVAC system to minimize dust, maintain a temperature of 30° C or less, and 5-95% non-condensing relative humidity.

The HVAC requirements for fiber optic terminal equipment are more stringent than what is required for RTU equipment. Therefore, whenever line protection or SPS specifies the use of fiber optic communications and its terminal equipment, Telemetering Requirements (Hardware) will match those.

NOTE: Environmental controls for microwave terminal equipment (when applicable) are generally more stringent than fiber optic terminal equipment and will be addressed on a case-by-case basis.

4.9 VEA Access Requirements

After the communication equipment is installed and in operation, the Producer shall provide 24 hours a day, 7 days a week accesses to Valley Electric employees and approved contractors for planned maintenance and service restoration.

5. METERING REQUIREMENTS

5.1 Purpose

This section specifies the metering requirements for Generating Units interconnecting to VEA transmission facilities.

5.2 **Basic Metering Requirements**

VEA meter(s) shall be installed for telecommunication data points and to measure auxiliary load per Valley Electric metering standards and requirements. For each generator, or bank of generators, one CAISO meter shall also be installed to measure net generation and, in addition, CAISO meter(s) shall be installed to measure other quantities required by the CAISO per CAISO metering standards and requirements (e.g. auxiliary load, generator output). The CAISO meter type(s) shall be specified by the CAISO and shall meet CAISO metering standards and requirements. Generation Entities directly connected to the CAISO Controlled Grid are responsible for installing, operating, and maintaining CAISO delivery meters in accordance with applicable CAISO requirements. Generation Entities connected to the CAISO Controlled Grid are required to provide Valley Electric access to the Producer's meter. All CAISO 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.

The Producer shall provide Valley Electric the transmission line section parameters required and used to program the meter(s) to account for losses associated with the Producer's transmission line.

The preferred and typically most cost effective method of metering the Generating Facility is to utilize one set of instrument transformers for both the CAISO meter and VEA meter where the VEA meter also serves to measure auxiliary load, i.e. bi-directional metering. Specialized extended range Current Transformers (CT's) are required for this type of installation. If the high voltage side facility circuit breaker is on the VEA service side of the metering CT's and Potential Transformers (PT's), a separate set of dry contacts must be provided to each VEA meter whose open/close status indicates whether the facility is energized.

The alternative method of metering the Generating Facility is to utilize one set of instrument transformers for the CAISO meter and VEA meter and one, or up to a maximum of two, VEA metering points to measure auxiliary load. At each auxiliary load metering point, the CT/PT enclosure, meter panel, pull section, disconnect switches, etc. shall be reviewed and approved by Valley Electric. If the high voltage side facility circuit breaker is on the VEA service side of the metering CT's/PT's, a set of dry contacts must be provided to each auxiliary load meter whose open/close status indicates if the facility is energized. In addition, a set of dry contacts must be supplied to each VEA auxiliary load meter indicating whether the generator output breaker is in the closed or open position. Given this metering configuration, the meter measures power to auxiliary load when the generator output breaker is closed, the generator is operating and auxiliary load is being provided to the generating facility.

5.3 **Location of Metering**

It is preferred the auxiliary load metering instrument transformers be located on the transmission high-side of the facility. The alternative is to place the auxiliary load metering instrument transformers on the low voltage side of the main Generating Facility transformer bank. If located on the low voltage side of the main Generating Facility transformer bank, the Producer shall provide certified transformer test reports that indicate transformer losses, used to program the meter(s) which will account for transformer losses. No metering instrument transformers (used for VEA metering purposes) shall be located behind any other transformers other than the main Generating Facility transformer bank.

Exceptions may be granted if it can be demonstrated that high-side metering will create significant safety issues or impose extraordinary costs not typically associated with such metering. CAISO Metered Entities that have installed low side metering shall supply the Transformer Loss Correction (TLC) as specified in CAISO's Metering Protocol Section. If it is not possible to install metering at the delivery point, the readings of the meter(s) shall be adjusted to correct for transformation and line losses. A two (2) percent adjustment factor for each stage of transformation shall be applied to the meter readings for bundled (full-service) VEA Producers.

The meter enclosure shall be owned and maintained by the Producer. The distance between the meter enclosure and the revenue-metering transformers must not exceed 50 feet to maintain the required metering accuracy. Valley Electric must approve any variance from this general rule. The enclosure must be located within and grounded to the substation ground grid. Access to the enclosure must be arranged so

Valley Electric personnel can inspect the meters without entering the substation yard. The enclosure must be equipped with an auxiliary 120-volt ac duplex plug, an overhead light, a light switch adjacent to the door, and a ground bus connected to the ground and mounted near the bottom of the wall where the meters are to be located.

5.4 **Metering Producer's Loads**

When a Producer delivers power to the VEA Power System, electric service to the auxiliary load associated with the Producer plant may also be needed. Because deliveries to and from the plant must be separately recorded and treated as separate transactions, additional revenue-metering will be required in most cases. All meters shall be equipped to prevent reverse registration. In addition, when a Producer enters into a service agreement with VEA for stand-by service, the Producer shall allow VEA to tap onto CAISO metering circuit with the installation cost to be borne by the end-user (Producer). Retail service will be measured using a VEA owned meter including VEA owned metering PT's and CT's.

5.5 **Metering Specifics**

VEA and CAISO meters will be form 9, class 20 meters per American National Standards Institute (ANSI) C12 standards. The CAISO meters shall meet all CAISO standards and requirements. Each meter shall utilize its own dedicated test switch. VEA will supply a test switch for each VEA meter or provide manufacturer and model number for mandatory test switches to be installed.

National Electrical Manufacturer Association (NEMA) 3R type (or a higher rated NEMA water-tightness rating) enclosures shall be used for outside metering installations.

All VEA owned meters (i.e. CAISO back-up and/or auxiliary load meters) shall require an uninterruptible 120VAC or 125VDC power supply (UPS) to keep them energized for at least 8 hours in the event the facility has an outage. A separately fused position or breaker position from the uninterruptible power supply shall be provided to each VEA meter. Each VEA meter shall be provided a separate set of dry A-finger contacts to indicate the open/close status of the main facility circuit breaker. The exception is if the metering PT's/CT's are on the VEA supply side of the of the main facility circuit breaker, then the VEA meter doesn't require this interface. The uninterruptible power supply wiring shall terminate to a terminal strip in the metering cabinet or on the wall plate. This terminal strip may be the same as used for the PT and CT secondary leads. A separate terminal strip shall be installed to accommodate the main breaker A-finger contact wires. A standard 120VAC receptacle, heater strip and a light with a switch shall be provided and installed in outdoor metering cabinets.

5.6 **Instrument Transformers**

The metering PT's and CT's shall be 0.3% ANSI accuracy class, or higher. If the instrument transformers used for auxiliary load metering are located on the transmission side of the facility, special extended range CT's are required, i.e. guaranteed and tested to accurately measure current down to at least 0.5% of CT rating. The metering unit CT's shall have a minimum B-1.8 ANSI burden rating and the PT's shall have a minimum Z rated ANSI burden. The metering CT's shall be sized in accordance to good metering practices and shall always be within meter accuracy class range during generation cycles and/or auxiliary load cycles.

If the alternative method of metering auxiliary power is utilized (i.e. metering auxiliary load on the low voltage side of the main Producer transformer bank in addition to metering at the net-generation point), the CT/PT enclosure, meter panel, pull section, disconnect switches, etc. at each auxiliary load metering point shall be reviewed and approved by Valley Electric. No appreciable capacitance, inductance, or resistance shall be located between the devices. Disconnect switches shall be located on both sides of transmission level metering PT's and CT's. It is permissible to locate the main instrument breaker between one of these disconnect switches and the metering PT's and CT's.

Generally, all transmission voltage-level metering CT's and PT's shall be freestanding. Any exceptions must be reviewed and approved by Valley Electric. The primary side of the metering units shall not be fused and shall not have any sort of switch or disconnect capable of de-energizing the metering units without de-energizing the circuit being metered.

There should be no means or possibility of by-passing metering CT's except by use of temporary high voltage jumpers. No unmetered auxiliary load is permissible on the source side of the VEA metering. PT's (or CCVT's) used for protection, monitoring and/or synching purposes may be located upstream of the VEA metering with the condition no appreciable load will be drawn from it. Under this circumstance, the Producer will provide VEA applicable specifications, drawings, and wiring diagrams for verification the PT's (or CCVT's) will not draw any appreciable load. The metering unit CT's and PT's shall be inductive type. CCVT types can only be used if Valley Electric Engineering reviews and approves the specific model and type. Spare metering CT's and PT's shall either be stored on site or be installed redundantly. All metering CT's shall be utilized for revenue metering, which includes VEA meter(s) and CAISO meter(s). The PT voltage coils shall be utilized for revenue metering, which includes VEA meter(s) and CAISO meter(s). If the metering PT has a second set of coils, it may be used for protection, monitoring, and/or synching purposes with the condition no appreciable load will be drawn from it.

The Producer will provide Valley Electric applicable specifications, drawings, and wiring diagrams for verification that the second set of PT voltage coils will not draw any appreciable load. All CT and PT secondary leads shall be terminated to a termination strip located in or near the metering cabinet. This may be the same terminal strip required to terminate the UPS wires. A separate terminal strip is required for the main breaker status and/or generator output breaker leads if breaker status is metered. PT secondary fused disconnect switches must be installed in close proximity to the metering PT's. Each VEA meter shall have a dedicated fused disconnect switch that is readily accessible (i.e., no ladder required to access) and clearly labeled. CT shorting blocks must be installed in close proximity to the metering CT's switch that is readily accessible (i.e., no ladder required to access) and clearly labeled. They will be available to isolate the CT's from all load-side (downstream) metering. All CT secondary non-polarity leads shall be tied together and grounded as close to the CT's as practical. One common wire shall emerge from this point which extends to the appropriate position on the metering connection terminal strip. This is in addition to the 3 CT secondary polarity leads that also extend to the appropriate positions on the metering connection terminal strip next to each VEA meter. All PT secondary non-polarity leads shall be tied together and grounded as close to the PT's as practical. One common wire shall emerge from this point which extends to the appropriate position on the metering connection terminal strip. This is in addition to the 3 PT secondary polarity leads that also extend to the appropriate positions on the metering connection terminal strip. There shall only be one grounding point for the PT secondary neutral and CT secondary non-polarity wires. The PT secondary neutral and CT secondary non-polarity leads can connect to separate grounding points or a common grounding point. CT and PT neutral common wires shall not be shared.

5.7 Power and Grounding Requirements

The Producer shall provide a connection point to station ground within ten (10) feet of the VEA communication equipment rack(s). VEA 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 Producer shall provide two 10 Amp dedicated branch circuits from the 125 VDC station power to support the telecommunications equipment rack(s). The dedicated source breakers shall be labeled "VEA -Telecom A" and "VEA -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. This power source shall not be shared with other equipment.

The Producer 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 Producer shall provide ample lighting for the safety of installation and maintenance personnel.

5.8 Project Roles and Responsibilities

The Producer shall procure the primary CAISO meter and manage all aspects to program and install the CAISO primary meter per CAISO requirements and practices. The Producer shall procure and manage all

aspects of the programing for, and installation of, ancillary CAISO meter equipment such as remote intelligent gateways (RIG), data processing gateways (DPG), routers, and cabling per CAISO requirements and practices. The Producer shall provide to Valley Electric Engineering, in writing, projected load and generation information including projected maximum and minimum current levels, in-rush current, harmonic content level, load/generation profile and any other pertinent data. The Producer shall provide to Valley Electric Engineering all preliminary meter related electrical and structural design drawings. The Producer shall provide to Valley Electric Engineering all preliminary metering equipment specifications and attributes (i.e. CT secondary wire sizes, lengths, and calculated burden). Only upon Valley Electric Engineering's approval of preliminary drawings and metering equipment specifications may final design drawings be issued for construction and metering equipment purchased by the Producer. The Producer shall provide to Valley Electric Engineering two copies each of the final design drawings, CT/PT test reports, other meter related equipment test reports/specifications, the main transformer test report (if applicable), and all other metering related information.

The Producer shall notify Valley Electric Engineering of any proposed upgrades or changes to the VEA meter or metering scheme, and Valley Electric Engineering shall be responsible for approval of any aforementioned upgrades or changes. The Producer shall comply with all CAISO requirements and obtain all necessary CAISO approvals before the facility can begin generating power. Valley Electric Meter Electricians shall procure, wire and install the VEA meter(s), meter test switches, A-base adapters, and all equipment beyond a termination block located in or near the metering cabinet (or wall plate). The installation of CAISO meters can be by anyone with sufficient experience, but shall be inspected by a CAISO-certified meter Inspector. Prior to initial generation testing, Valley Electric must inspect, verify, and test all VEA meter-related wiring, connections, terminations, and metering PT's/CT's. The generating facility may not be energized until VEA has provided written notice that all metering components and wiring have been checked and verified as being acceptable by the Valley Electric inspector. The Producer shall accommodate and ensure that Valley Electric meter personnel have unrestricted 24hr/7day access to the VEA meters, metering PT's/CT's, and associated wiring/terminations/enclosures. Valley Electric will coordinate with the Producer on how to achieve 24hr/7day access, but Valley Electric normally utilizes two approaches for access:

1. VEA provides a lock to Producers facilities and VEA provides the Producer a key, or
2. VEA provides a combination lock to Producers facilities and VEA provides the Producer the combination.

6. PROTECTION AND CONTROL REQUIREMENTS

6.1 Purpose

This section specifies the requirements for protective relays and control devices for Generating Units interconnecting to VEA transmission facilities. Protection requirements are designed and intended to protect the Power System only. As a general rule, neither party should depend on the other for the protection of its own equipment.

6.2 Overview of Requirements

The Producer shall install at the Point of Interconnection, at a minimum, a disconnecting device or switch with generation interrupting capability. Protective relays are typically needed to protect Producer's facility adequately. It is the Producer's responsibility to protect its own system and equipment from faults or interruptions originating on both VEA's side and the Producer's side of the Interconnection. The Producer's system protection facilities shall be designed, operated, and maintained to isolate any fault or abnormality that would adversely affect the VEA Power System or the systems of other entities connected to the VEA Power System. The Producer shall, at its expense, install, operate, and maintain system protection facilities in accordance with applicable CAISO, WECC and NERC requirements and in accordance with design and application requirements of this Generation Interconnection Handbook. The protective relays used in isolating the Generating Facility from the VEA power system at the Point of Interconnection must be set to coordinate with the protective relays at the VEA line breaker terminals for

the line on which the Generating Facility is connected. Additional requirements, as to the exact type and style of the protective devices, may be imposed on the Producer based on the proposed station configuration or the type of interrupting device closest to the point of common coupling to VEA's facility. Note: There may be additional protective equipment requirements, at the Producer's cost, which VEA will coordinate with the Producer or its representatives. VEA recommends that the entity acquire the services of a qualified electrical engineer to review the electrical design of the proposed Generating Facility and ensure that it will be adequately protected. Generally, fault-interrupting equipment should be located as close to the interconnection point as possible – typically within one span of overhead line or 200 feet of non-spliced underground cable. The Producer should provide VEA with electrical drawings for review prior to equipment procurement. The drawings provided should consist of Single Line Meter and Relay Diagrams, schematic drawings detailing connectivity (3-Line AC (Alternating Current)) and tripping schemes (Direct Current (DC)) for all VEA required relays. The Single Line Meter and Relay Diagrams listing the major protective equipment should be provided for review prior to ordering relays. The 3-Line AC and the DC schematics should be provided before fabricating relay panels.

6.3 **Protection and Control System Information to Accommodate Producer Interconnection**

At the Producer's expense, VEA will perform a detailed interconnection study to identify the cost of any required modifications to VEA's protection and control systems that are required to interconnect a new generation source.

The Producer should provide VEA with electrical drawings for review and approval prior to equipment procurement. The drawings provided should consist of Single Line Meter and Relay Diagrams, schematic drawings detailing connectivity (3-Line AC) and tripping schemes (DC) for all VEA required relays. The Single Line Meter and Relay Diagrams listing the major protective equipment should be provided prior to ordering relays. The 3-Line AC and the DC schematics should be provided before fabricating relay panels. The following documents must be submitted for Valley Electric review and approval before any agreements are executed: Single Line Diagram, Single Line Meter and Relay Diagrams.

The Producer must also provide Valley Electric with test reports for the particular types of protection devices, including verification of all protective functionality, before Valley Electric will allow the facility to parallel. Where tele-protection is utilized, the communication circuits must be tested and the scheme operation functionally verified prior to release for commercial operation. The Generator must submit written test reports for qualified testing to Valley Electric, or at any time upon request by VEA, that demonstrate that the relays are operable and within calibration.

Valley Electric will not test the Producer's equipment, but may witness the testing performed by a qualified testing firm retained by the Producer. On-site power (typically 120 volts) is required for the test equipment. Circuit breakers must be tested at least every eight years after initial inspection. It is also in the Generation Entity's best interest to make sure all of its protective equipment is operating properly, since significant equipment damage and liability can result from failures of the entity's protective equipment.

6.4 **Reliability and Redundancy**

The Producer shall design the protection system with sufficient redundancy that the failure of any one component will still permit the Generating Facility to be isolated in the required clearing time from the VEA power system under a fault condition. Multi-function three-phase protective relays used for line protection must have redundant relay(s) for backup. The required breakers must be trip tested by the Producer at least once a year.

6.5 **Calibration of Producer Owned Protective Apparatus**

The Producer must test the protective apparatus it owns on a routine basis in order to prove correct calibration and operation of the devices. Required test intervals of these protective apparatus have been established as every two years. The Producer should email calibration reports to the manager of engineering at: VEAengineering@vea.coop.

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

6.6 Relay Grades and Standard Relays

Only utility grade relays can be used for interconnection protection, and must meet the latest revisions of the following specifications:

- The minimum and maximum operating temperatures are the range of -40° to 70° C.
- Must be certified to meet ANSI/IEEE (Institute of Electrical and Electronics Engineers, Inc.) C37.90 dielectric testing requirements.
- Must be certified to meet ANSI/IEEE 37.90.1 Surge Withstand Capability (SWC) and Fast Transient testing.
- Must be certified to meet Radio Frequency Interference (RFI) with stand capability in accordance with ANSI/IEEE C37.90.2.
- Must meet Power Frequency Magnetic Field Immunity (ANSI/IEEE 1308-1994 (R2001) and International Electrotechnical Commission (IEC) 61000-4-8).
- Must meet Underwriters Laboratory (UL) and Federal Communications Commission (FCC) test requirements as necessary.
- Must be certified for output contact Load Break Capability tests- through an inductive network (UL-1054, ANSI C37.90).
- Airborne Arcing Noise susceptibility (IEEE C62.41.2, C62.45 and IEEE 896.5).
- Must be certified for DC Hi-pot Test or Megger with no leakage or breakdown of the components (IEC 61000-4-11 and 60255-11).
- Electrostatic Discharge Immunity (ANSI/IEEE C37.90).
- Must be certified to meet IEC 60255-21-1 Class 1 Vibration test (sinusoidal) or equivalent tests and IEC 60255-21-2 Class 1 Shock and bump or equivalent tests.

6.7 Typical Types of Relays Producer may be Required to Install (may be more than listed)

6.7.1 Phase over-current (ANSI Device ID 50P and 51P)

Overcurrent protection must be able to detect a line-end fault condition. A phase instantaneous overcurrent relay that can see a line fault under sub-transient conditions is required.

6.7.2 Reverse Power Relay (ANSI Device ID 32R)

Reverse power relay is one which functions upon a reverse power flow at a given set point.

6.7.3 Over/Under-voltage Relay (ANSI Device ID 27 and 59)

This protection is used to trip the circuit breaker when the voltage is above or below an acceptable operating range, specified by Valley Electric. It is used for generator protection and backup protection in the event that the generator is carrying load that has become isolated from the VEA transmission system.

6.7.4 Over/Under-frequency Relay (ANSI Device ID 81U/O)

This protection is used to trip the circuit breaker when the frequency is above or below an acceptable frequency range as specified by NERC PRC-024 standard the CAISO and VEA follow. It is used for generator and/or turbine protection and back-up protection. Generator frequency relay settings are coordinated with other utilities in the WECC and the CAISO to maintain generation on-line during system disturbances. Relay settings must be set to conform with NERC standard PRC-024-2. No deviations will be permitted without prior written approval by VEA and the CAISO.

6.7.5 Overcurrent Relay with Voltage Restraint/Voltage Control or Impedance Relay (ANSI Device ID 51V)

These relays are used to detect multi-phase faults and initiate a generator circuit breaker trip. The relays must be located on the individual generator feeder. A group of generators aggregating over 400 kW must have an impedance relay or an overcurrent relay with voltage restraint located on each generator greater than 100 kW. Generators equal to or greater than 400 kW must have an impedance relay or an overcurrent relay with voltage restraint. As determined by VEA protection studies, an overcurrent relay with voltage control may also be acceptable if it can be set to adequately detect end-of-line faults. If the generator step-up transformer is connected wye-delta or delta-wye, a delta-wye or wye-delta auxiliary potential transformer is required on the potential circuits to the voltage restraint or voltage controlled overcurrent relay for phase shift correction based on the relay design and operating principal. The Producer should contact the Valley Electric Engineer for assistance in the proper connection of the auxiliary transformers.

6.7.6 Ground Fault Sensing Scheme (ANSI Device ID 87RGF)

The ground fault sensing scheme detects ground faults on VEA transmission facilities and trips the generator breaker or the generating facility's main circuit breaker, thus preventing the generating unit from contributing to a ground fault. This scheme must be able to detect faults between VEA's side of the dedicated transformer and the end of VEA's line segment. The following transformer connections, along with appropriate relaying equipment, are commonly used to detect system ground faults:

- System side - ground wye: generator side -delta
- System side – ground wye: generator side – wye; tertiary – delta

6.7.7 Islanding Protection (ANSI Device ID 86)

Generating facilities operating in parallel with VEA'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 VEA's electric system and loads become isolated from the remainder of VEA'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. For generation facilities aggregating 10 MW or greater, Valley Electric may elect to use a voltage phase comparison system for islanding protection while retaining the voltage and frequency relays for backup.

6.8 Line Protection (ANSI Device ID 21L and 87L)

Line protection relays must coordinate with the protective relays at the VEA breakers for the line on which the Generating Facility is connected. The typical protective zone is a two-terminal line section with a breaker on each end. In the simplest case of a load on a radial line, current can flow in one direction only, so protective relays need to be coordinated in one direction and do not need directional elements. However, on the typical transmission system, where current may flow in either direction depending on system conditions, relays must be directional. Also, the complexity and the required number of protective devices increase dramatically with increase in the number of terminals in each protective zone. The VEA-required relays must be located so that a fault on any phase of the VEA transmission facility shall be detected. If transfer trip protection is required by Valley Electric, the Producer shall provide all required communication circuits at its expense. A communication circuit may be a leased line from the telephone company, a dedicated cable, microwave, or a fiber optic circuit and shall be designed with sufficient levels of monitoring of critical communication channels and associated equipment. Valley Electric will determine the appropriate communication medium to be used on a case-by-case basis. The leased phone line or dedicated communication network must have high-voltage protection equipment on the entering cable so the transfer trip equipment will operate properly during fault conditions. VEA transmission and distribution facilities are designed for high reliability by having multiple sources and paths to serve Producers. Due to the multiple sources and paths, complex protection schemes are required to properly detect and isolate faults. The addition of any new Generating Facility to the VEA transmission facilities must not degrade the existing protection and control schemes, create safety concerns or cause service reliability to drop to levels that violate minimum reliability standards.

The tables below provide guidelines for selection of primary and backup relays depending on the transmission line protection application. Additionally, the relay elements are listed for each protection application.

A. 230 kV or 138 kV (Two Terminal)

Relay	Relay Model #	Element	Element Name
Primary/Backup Relay	SEL-311L or SEL-411L	87L	Line Current Differential
		21P1	Zone 1 Mho Phase Distance
		21G1	Zone 1 Mho Ground Distance
		21P2	Zone 2 Mho Phase Distance
		21G2	Zone 2 Mho Ground Distance
		21P3	Zone 3 Mho Phase Distance (Application Specific)
		21G3	Zone 3 Mho Ground Distance (Application Specific)
		51G	Directional Ground Time Overcurrent
		SOTF	Switch-Onto-Fault
		79	Automatic Reclosing (Only use this function if there is existing SEL-311L relaying at station using this function. Otherwise this function will be performed by a different relay.)

B. 138 kV (Radial)

Relay	Relay Model #	Element	Element Name
Primary/Backup Relay	SEL-311C	21P1	Zone 1 Mho Phase Distance
		21G1	Zone 1 Mho Ground Distance
		21P2	Zone 2 Mho Phase Distance
		21G2	Zone 2 Mho Ground Distance
		21P3	Zone 3 Mho Phase Distance (Application Specific)
		21G3	Zone 3 Mho Ground Distance (Application Specific)
		51P	Phase Time Overcurrent (LOP)
		51G	Directional Ground Time Overcurrent
		SOTF	Switch-Onto-Fault
		79	Automatic Reclosing (Only use this function if there is existing SEL-311L relaying at station using this function. Otherwise this function will be performed by a different relay.)

6.9 **Station Battery**

A stationary battery, either a flooded lead acid type or NiCd type, is required to power utility grade relays and for tripping the breaker.

6.10 **Dedicated Transformer**

A dedicated transformer is required to step-up the generator voltage to the interconnection level and isolate the Producer from other Producers. The available voltage taps of a Generating Unit's step-up transformer must be reviewed by Valley Electric for their suitability with VEA's system. The Producer is to request this review before acquiring the transformer. The Generating Unit's transformer, with correct voltage taps, helps maintain a specified voltage profile on VEA's system for varying operating conditions.

The impedance of a dedicated transformer limits fault currents on the generator bus from the VEA Power System and also limits fault currents on the VEA Power System from the generator. Hence, it reduces the potential damage to both parties due to faults. It also must have a delta winding to reduce the generator harmonics entering the VEA Power System. The delta winding will also reduce the VEA Power System harmonics entering the generation facility.

A high-side fault-interrupting device is required for transformer protection. A three-phase circuit breaker is recommended, but fuses are acceptable for generation facilities of less than 1 MW, providing that coordination can be obtained with the existing VEA protection equipment. If fuses are used, it is recommended that the Producer install single-phase protection for its equipment.

Lightning arrestors, if the Producer chooses to install them, must be installed between the transformer and the fault-interrupting devices and be encompassed by the generator's relay protection zone.

6.11 **Switching and Tagging Rules**

Valley Electric 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 Valley Electric's switching and tagging rules, the Producer shall allow Valley Electric to place its locks on the Producer's Interconnection Facilities, as may be required (specifically disconnect switches and/or circuit breakers on the Producer's terminus of the generation tie-line). The locking feature of disconnects may be utilized by either party when inter-company clearances are issued on the generation tie-line.

6.12 **Manual Disconnect Switch**

A VEA-operated disconnect device must be provided as a means of electrically isolating the VEA Power System from the Generating Facilities at the Point of Change of Ownership. This device shall be used to establish visually open working clearance for maintenance and repair work in accordance with Valley Electric safety rules and practices. A disconnect device must be located at all points of interconnection with VEA. This disconnect switch should be gang operated, three-pole lockable switch. If the switch is to be located on the VEA side of the Point of Change of Ownership, Valley Electric will install the switch at the Producer's expense. If the device is to be located on the Producer's side, it must be furnished and installed by the Producer. All switch installations must be approved by Valley Electric. Valley Electric personnel shall inspect and approve the installation before parallel operation is permitted.

The isolating disconnect may be placed in the line disconnect position on the high side of the Producer's generation tie-line. A separate ground disconnect shall also be incorporated and placed in the line position on the high side of the Producer's generation tie-line.

For 230 kV and below, the disconnects must be 3-phase, gang-operated disconnects with a common operating handle.

The operating handle of the line disconnect/disconnects must include a provision for locking and tagging the disconnect control handle/handles in the open positions. The operating handle of the ground disconnect/disconnects must include a provision for locking the disconnect control handle/handles in the closed positions.

For manual Line disconnects, the device must:

- Provide unrestricted, 24-hour access to Valley Electric personnel.
- Allow visible verification that separation has been accomplished.
- Be capable of being locked and tagged in the open position.
- Be clearly labeled with permanent signage approved by Valley Electric.

6.13 Fault-Interrupting Devices

The fault-interrupting device selected by the Producer must be reviewed and approved by Valley Electric for each particular application.

There are two basic types of fault-interrupting devices:

- Circuit Breakers (see section below)
- Circuit Switchers (see section below)

Valley Electric will determine the type of fault-interrupting device required for a generation facility based on the size and type of generation, the available fault duty, the local circuit configuration, and the existing VEA protection equipment.

6.14 Circuit Breakers

A three-phase circuit breaker at the point of interconnection automatically separates the generation facility from the VEA Power System upon detection of a circuit fault. Additional breakers and protective relays may be installed in the generation facility for ease in operating and protecting the facility, but they are not required for the purpose of interconnection. The interconnection breaker must have sufficient capacity to interrupt maximum available fault current at its location and be equipped with accessories to:

- Trip the breaker with an external trip signal supplied through a battery (shunt trip).
- Telemeter the breaker status when it is required.
- Lockout if operated by protective relays required for interconnection.

Generally, a three-phase circuit breaker is the required fault-interruption device at the point of interconnection, due to its simultaneous three-phase operation and ability to coordinate with VEA line-side devices.

Typical VEA circuit breaker protection relays are shown below for Customer information and coordination. This information should be used for Customer selection of their primary and backup relays.

A. 230 kV or 138 kV

Relay	Relay Model #	Element	Element Name
Primary Relay	SEL-351S	25	Synchronism Check
		50BF	Breaker Failure
		52CS	Front Panel Breaker Control
		79	Automatic Reclosing (Only use this function if there is existing SEL-311L relaying at station using this function. Otherwise this function will be performed by a different relay.)

B. 138 kV (Transformer Breaker)

Relay	Relay Model #	Element	Element Name
Primary Relay	SEL-351S	50BF	Breaker Failure
		52CS	Front Panel Breaker Control

6.15 Circuit Switchers

A circuit switcher is a three-phase fault-interrupter with limited fault interrupting capability. These devices may substitute for circuit breakers when the fault duty is within the interrupting rating of the circuit switcher. With Valley Electric approval, some circuit switchers with blades can double as the visual open disconnect switch between the metering transformers and the main transformer. Since circuit switchers do not have integral current transformers, they must be installed within 30 feet of the associated current transformers to minimize the length of the unprotected line/ bus disturbance.

6.16 Permissive Close for Interrupting Device at Point of Interconnection

VEA will provide a permissive close control signal to enable closing of the Producer's interrupting device at or near the Point of Interconnection, which is typically the circuit breaker(s) at the VEA bus position. The intent of this control is to ensure that VEA is ready for the Generating Facility to be energized from the VEA power system, and to prevent the closing of the Producer's interrupting device when the VEA facility is de-energized. The Producer must incorporate the interface to VEA's permissive close control signal communication interface in the design of the associated interrupting device close circuit(s). In addition, the Producer may need to provide status of the interrupting device (open or closed) to Valley Electric via the communication control interface.

6.17 Generator Standards

The Generating Unit must meet all applicable ANSI and IEEE standards. This prime mover and the Generating Unit should also be able to operate within the full range of voltage and frequency excursions that may exist on the VEA Power System without damage to the prime mover or Generating Unit. The Generating Unit must be able to operate through the specified frequency ranges for the time durations listed in the WECC Off-Frequency standard (PRC-006-WECC-CRT-2) to enhance system stability during a system disturbance.

6.18 Voltage Regulator

Voltage control is required for all Generating Units interconnected at transmission level voltages. The unit should be able to operate in Automatic Voltage Control Mode with its automatic voltage regulator (AVR) in service and controlling voltage continuously; except when instructed otherwise by the Transmission Operator (TOP), or it is in starting, shutting down or testing mode. If the Voltage Control equipment is out of service, the generator operator shall have an alternative method to control generator voltage and reactive output to meet the voltage or reactive power schedule directed by Valley Electric (per applicable NERC Reliability Standard: NERC Reliability Standard VAR-002-4 or any future revisions) and as directed by the CAISO. The regulator must be acting continuously and be able to maintain the specified voltage or reactive power schedule at the interconnection point under steady-state and contingency conditions without hunting and within +0.5 percent of any voltage level between 95 percent and 107 percent of the nominal voltage at the point of interconnection.

6.19 Voltage Criteria

The operating voltages of the VEA transmission system are 230 kV and 138 kV. The transmission system is a mix of two-terminal and radial transmission line configurations. VEA's operating practice is to maintain voltage within +8/-5% of nominal system voltage for their transmission system. For emergency or contingency operation system voltage is maintained within +/-10%. Steady State voltages are provided below.

		Steady State Pre-Contingency		**Steady State Post-Contingency**	
System	Facility	**High (kV/p.u.)**	**Low (kV/p.u.)**	**High (kV/p.u.)**	**Low (kV/p.u.)**
All Busses	230KV	248.4/1.080	218.5/0.950	253/1.100	207/0.900
		149.0/1.080	131.1/0.950	151.8/1.100	124.2/0.900

6.20 **Power Factor Controller**

The controller must be able to maintain a power factor setting within +1 percent of the setting at full load at any set point within the capability of generator. However, in no case shall control limits be greater than FERC Order 827, which states:

> FERC Order 827 Power Factor Design Criteria
>
> 1.8.1.1 Synchronous Generation. The Producer shall design its Small Generating Facility to maintain a composite power delivery at continuous rated power output at the Point of Interconnection at a power factor within the range of 0.95 leading to 0.95 lagging, unless the Transmission Provider has established different requirements that apply to all similarly situated synchronous generators in the control area on a comparable basis. The requirements of this paragraph shall not apply to wind generators.
>
> 1.8.1.2 Non-Synchronous Generation. The Producer shall design its Small Generating Facility to maintain a composite power delivery at continuous rated power output at the high-side of the generator substation at a power factor within the range of 0.95 leading to 0.95 lagging, unless the Transmission Provider has established a different power factor range that applies to all similarly situated non-synchronous generators in the control area on a comparable basis. This power factor range standard shall be dynamic and can be met using, for example, power electronics designed to supply this level of reactive capability (taking into account any limitations due to voltage level, real power output, etc.) or fixed and switched capacitors, or a combination of the two. This requirement shall only apply to newly interconnecting non-synchronous generators that have not yet executed a Facilities Study Agreement as of the effective date of the Final Rule establishing this requirement (Order No. 827).
>
> The following reactive power requirements apply only to a newly interconnecting wind generating plant that has executed a Facilities Study Agreement as of the effective date of the Final Rule establishing the reactive power requirements for non-synchronous generators in section 9.6.1 of this LGIA (Order No. 827). A wind generating plant to which this provision applies shall maintain a power factor within the range of 0.95 leading to 0.95 lagging, measured at the Point of Interconnection as defined in this LGIA, if the Transmission Provider's System Impact Study shows that such a requirement is necessary to ensure safety or reliability. The power factor range standard can be met by using, for example, power electronics designed to supply this level of reactive capability (taking into account any limitations due to voltage level, real power output, etc.) or fixed and switched capacitors if agreed to by the Transmission Provider, or a combination of the two. The Producer shall not disable power factor equipment while the wind plant is in operation. Wind plants shall also be able to provide sufficient dynamic voltage support in lieu of the power system stabilizer and automatic voltage regulation at the generator excitation system if the System Impact Study shows this to be required for system safety or reliability.

6.21 **Inverter-based Generators (Solar, Wind, Battery and others)**

Inverter based generation must comply and meet the latest applicable IEEE 1547, UL 1741 and WECC standards. The harmonic generated by these inverters must be less than 1% for single harmonic and less

than 5% for total harmonic. At VEA's request, all voltages, frequencies, and set points must be verified by providing calibration test reports showing pass/fail indication.

6.22 Induction Generators

Induction generators and other generators with no inherent VAR (reactive power) control capability shall be required to provide an amount of reactive power equivalent to that required for a synchronous generator in FERC Order 827.

Induction machines can be self-excited with the nearby distribution capacitors, or as the result of the capacitive voltage on the distribution network. Interconnecting facility should provide for a reclose block mechanism to avoid unintended operation of the unit following an outage on the distribution feeder to which it is interconnected.

6.23 Remedial Action Schemes / Special Protection Systems

As stated in the NERC and WECC Planning Standards, the function of a Special Protection System (SPS), also referred to as a Remedial Action Scheme (RAS), is to "detect abnormal system conditions and take pre-planned, corrective action (other than the isolation of faulted elements) to provide acceptable system performance." In the context of new generation projects, the primary action of a RAS would be to detect a transmission facility outage or an overloaded transmission facility and then trip or run back (reduce) generation output to prevent damage to the overloaded facilities, protect against potential overloads, and/or avoid other criteria violations.

The need for RAS is determined through the CAISO Generation Interconnection Process studies. The Producer is informed of their RAS participation, if any, as part of these studies. Whether RAS shall be required on a specific generating station will depend on various factors including total generation exports from VEA's area, location and size of the generator, the nature, consequences and expected frequency of grid disturbances and future transmission projects.

Any RAS proposals must be approved by both VEA and CAISO and must comply with the applicable CAISO Planning Standards and Good Utility Practice. VEA also expects all RAS operating on its System to be taken to WECC RASR Committee for approval prior to final design and construction.

Valley Electric, the CAISO and PeakRC will monitor the status and operation of RAS.

7. SUBSTATION REQUIREMENTS

7.1 Purpose

This section provides guidelines for:

- The determination of breaker duty and surge protection for generation facilities connecting to VEA transmission facilities.
- Engineering and design of grounding systems for generation facilities connecting to VEA transmission facilities.
- Establishing the methodology used by Valley Electric to determine equipment ratings.
- These equipment ratings will be used in determining ratings of Electric Facilities on VEA transmission facilities.
- The selection of substation insulation for generation connecting to VEA transmission facilities.

References

- SES-3801 – Substation Arrestor Selection Requirements
- SE-1301 – Substation and Transmission Equipment Rating Methodology
- SE-1302 – Substation Conductor Rating Methodology
- IEEE C62.22 Guide to the Application of Metal-Oxide Surge Arrestors for Alternation Current Systems
- IEEE 80 Guide for Safety in AC Substation Grounding

- IEEE Std C62.82.1, IEEE Standard Insulation Coordination-Definitions, Principles and Rules
- IEEE 1313.2, IEEE Guide for the Application of Insulation Coordination

7.2 **Bus Protection**

VEA typical bus protection relays are shown below for Customer information and coordination. Ring-bus is the primary configuration used in VEA's system for 230 kV and 138 kV bus design. Under this configuration, protection of the bus is provided by transmission line and transformer relays and circuit breakers. For other bus configurations (such as a straight bus), VEA will provide guidance on the Customer's selection of primary and backup relays as part of the interconnection process.

A. 230 kV or 138 kV Transmission Bus

Relay	Relay Model #	Element	Element Name
Primary Relay	SEL-587Z	87B	High Impedance Bus Differential

7.3 **Transformer Protection**

VEA typical transformer protection relays are shown below for Customer information and coordination. Generally, "Winding 1" elements refer to protective elements applied to the high-voltage winding of the transformer. "Winding 2" elements refer to the protective elements applied to the low-voltage winding of the transformer.

A. 230/138 kV Autotransformer Transformer with Delta Tertiary

Relay	Relay Model #	Element	Element Name
Primary Relay	SEL-387	87T	Transformer Current Differential
		REF	Restricted Earth Fault
		51P1	Winding 1 Phase Time Overcurrent
		51G1	Winding 1 Ground Time Overcurrent
		51P2	Winding 2 Phase Time Overcurrent
		51G2	Winding 2 Ground Time Overcurrent
Backup Relay	SEL-587	87T	Transformer Current Differential
		51P1	Winding 1 Phase Time Overcurrent
		51G1	Winding 1 Ground Time Overcurrent
		51P2	Winding 2 Phase Time Overcurrent
		51G2	Winding 2 Ground Time Overcurrent

B. 138/24.9kV Distribution Delta-Wye Transformer

Relay	Relay Model #	Element	Element Name
Primary Relay	SEL-387	87T	Transformer Current Differential
		50P1	Winding 1 Phase Instantaneous Overcurrent
		51P1	Winding 1 Phase Time Overcurrent

		50G1DT	Winding 1 Residual Ground Definite Time Overcurrent
		51P2	Winding 2 Phase Time Overcurrent
		51G2	Winding 2 Ground Time Overcurrent
Backup Relay	SEL-501 (X)	50P1	Winding 1 Phase Instantaneous Overcurrent
		51P1	Winding 1 Phase Time Overcurrent
		50G1DT	Winding 1 Residual Ground Definite Time Overcurrent
	SEL-501 (Y)	51P2	Winding 2 Phase Time Overcurrent
		51G2	Winding 2 Ground Time Overcurrent

7.3.1 Settings Guidelines

Please refer to VEA's "System Wide Protection Criteria" provided in a separate document during the interconnection process.

7.4 Producer Owned Duty/Surge Protection Equipment

The Producer shall provide, install, own, and maintain relays, circuit breakers and all other devices necessary to remove any fault contribution from their facilities related to any short circuit or adverse condition occurring on VEA's electric system or their system. The removal of the Producer's fault contribution shall be coordinated with the protective requirements of VEA's electric system. Such protective equipment shall include, but not limited to, a disconnecting device and a fault current-interrupting device located between the Producer's Transmission Facilities and VEA electric system at a site selected by the Parties. The Producer shall be solely responsible to disconnect their facility from adverse conditions on VEA's electric system.

7.5 Breaker Duty

The breaker duty for facilities connecting to VEA transmission facilities must be within allowable values. Fault duty may vary at different substations in VEA's grid, so a System Impact Study is executed in accordance with CAISO Interconnection Studies to determine specific circuit breaker fault duty ratings at specific locations.

The recognized standards to determine circuit breaker fault duties are: (i) for circuit breakers rated on a symmetrical current basis is IEEE Standard C37.010-1999(R2005), "IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis," and (ii) ANSI/IEEE Standard C37.5 for circuit breakers rated on a total current basis. Valley Electric will review breaker duty and surge protection to identify any additions required to maintain an acceptable level of VEA system availability, reliability, equipment insulation margins, and safety.

When studies of planned future system arrangements indicate that the fault duty will reach the capability of existing breakers, circuit breakers may need to be replaced. Other options considered to limit fault duty are: de-looping or rearranging transmission lines at substations and split bus arrangements.

Please note that VEA performs an annual short circuit duty analysis, which may include reevaluation of its facility breakers and other fault interrupting equipment.

7.6 Surge Protection

Facilities connecting to the VEA transmission facilities via underground cables will require surge protection. This applies to all transmission voltage levels. Furthermore, any new transmission-level transformer connecting to a VEA facility will require surge protection. The minimum surge protection

varies depending on the voltage level of the third party's connecting facility. Some utilities have opted to use metal oxide type surge arrestors for substation surge protection. Third-party owned facilities connecting to an VEA substation are required to use the latest revision of IEEE C62.22, Guide to the Application of Metal-Oxide Surge Arrestors for Alternation Current Systems, in order to determine the appropriate surge protection. In addition to using IEEE C62.22 for the application of surge arresters, any new connecting facility must meet the equipment requirements for surge arrester as dictated in Substation Engineering Standard SES-3801. SES-3801 describes and quantifies standard station class, metal oxide surge arrestors for 69 kV to 500 kV (Please see Table 4.7 under section 4.6.19).

7.7 Insulation and Insulation Coordination

Third-party owned facilities connecting to VEA transmission facilities will be required to coordinate with the insulation strength of the facility to which interconnection is made. A system transient analysis will be performed to determine the amplitude, waveform and duration of the over-stress voltages and generally done using software such as Electromagnetic Transient Program (EMTP). The insulation level will be in accordance with the latest revision of IEEE Std C62.82.1, "IEEE Standard Insulation Coordination-Definitions, Principles and Rules" and IEEE 1313.2, "IEEE Guide for the Application of Insulation Coordination".

All equipment will adhere to the chosen basic lightning impulse insulation level with the exception of the transformer windings, which are protected by surge arrestors.

7.7.1 Insulation Coordination

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 over-voltages. Insulation coordination must be done properly to ensure electrical system reliability and personnel safety.

The Producer shall be responsible for an insulation coordination study to determine appropriate surge arrester class and rating on their Transmission Facilities interconnecting into VEA's system. In addition, the Producer 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 to VEA for evaluation as part of the Producer's interconnection plan.

7.8 Equipment Rating

The ratings of Electric Facilities on VEA's transmission system are derived from the individual ratings of the equipment, or elements, which comprise that electric facility. Specifically, a Facility Rating will be equal to the most limiting applicable Equipment Rating of the individual equipment that comprises that Facility. Conductors, equipment, and material should be selected to prevent substation elements from being the most limiting element of a facility.

7.9 Substation Grounding

The Producer 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.

7.10 Ground Grid Requirements

Transformers connected to the transmission system must have a grounded wye connection on the system side, and a ground current sensing scheme must be used to detect ground faults on the VEA Power System.

Additionally, when Producer facilities (operated by Producer personnel) need to be connected to the ground grid of an existing or new VEA substation (i.e. when they are located inside or immediately adjacent to VEA substations or switching stations or when system protection requires solid ground interconnection for relay operation), the ground grid must meet the minimum design and safety requirements used in VEA substations.

When Producer facilities are not in any way connected to the VEA ground grid or neutral system, the Producer will be solely responsible for establishing design and safety limits for their grounding system per good engineering practice and applicable industry rules, regulations and standards.

7.11 Ground Mats

If the Producer facility and VEA substation ground mats are tied together, all cables may be landed without any protection. However, if the Producer facility and VEA 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 Producer facility 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 Producers shall perform appropriate tests, including soil resistivity tests, to demonstrate that their ground grid design meets the standard for their Producer facilities interconnected to VEA’s electric system. Mats shall be tested at regular intervals to ensure their effectiveness.

Grounding studies shall be performed with industry-recognized software to determine if Producer facility and VEA 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.

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 VEA system, the Producer shall conduct new grounding studies. Costs of studies and any changes required to meet safety limits and protect equipment shall be borne by the Producer.

The Producer is responsible to ensure that the Ground Potential Rise (GPR) of the Producer facility'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 Producer. If it is elected to install separate ground grids for VEA and the generation facility, the Producer shall be responsible to mitigate any transfer voltages and GPR that occur to VEA 's grid due to faults on the generation facility.

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 written approval by Valley Electric.

8. OPERATING REQUIREMENTS

8.1 Purpose

The purpose of this section is to provide Producers with a general understanding of applicable Valley Electric and CAISO operating procedures, communications and test reports.

8.2 Coordination between the CAISO and VEA Dispatch

On January 1, 2013, the CAISO assumed operational control over VEA's transmission grid. Notwithstanding the operational jurisdiction of the CAISO over VEA's transmission system, the CAISO Protocols delegate certain operational activities to Valley Electric. Under the CAISO's control and instruction, Valley Electric performs all physical switching operations, including de-energization and restoration of VEA facilities.

Both Valley Electric and the CAISO serve as points of contact for Generating Facilities that are connected to VEA transmission facilities. These Generating Facilities will communicate and coordinate with the CAISO and Valley Electric as specified in the CAISO's Protocols, Operating Procedures, and tariffs. Dispatch may be responsible for implementing some of the CAISO's orders, protocols, and operating procedures.

8.3 **Reactive Power Requirements**

Generally, the Producer must design its facility to meet FERC 827 reactive power requirements as shown in the table below.

FERC 827 - Power Factor Criteria		
	Interconnection at 230 kV	Interconnection at 138 kV
Power Factor	0.95 lag/lead at high side of generating facility	0.95 lag/lead at high side of generating facility

VEA shall not be obligated to supply or absorb reactive power for the Producer facility when it interferes with operation of VEA's electric system, limits the use of VEA interconnections, or requires the use of generating equipment that would not otherwise be required.

Producer VAR schedules, as needed, will be specified by Valley Electric 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 relevant criteria.

Producers 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 as they relate to their facilities.

Reactive power equipment utilized at a Producer facility to meet Valley Electric's Requirements must be designed to minimize the exposure of VEA 's electric customers, VEA 's electric system, and the electric facilities of others (i.e., other facilities and utilities in the vicinity) to:

- severe over-voltages that could result from self-excitation of induction generators,
- transients that result from switching of shunt capacitors,
- voltage regulation problems associated with switching of inductive and capacitive devices.
- unacceptable harmonics or voltage waveforms, which may include the effect of power electronic switching, and
- unacceptable voltage flicker.

The reactive power equipment utilized at a Producer facility to meet Valley Electric'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:

- The maximum allowable voltage rise or drop (measured at the point of interconnection with VEA's electric system) associated with a step change in the output of a Producer facility's reactive power equipment must be less than or equal to 1%; and

- The maximum allowable deviation from a Producer facility's reactive power schedule (measured at the point of interconnection with the VEA system) must be less than or equal to 10% of the Producer facility's maximum (boost) reactive capability.

8.4 Producer Communications to Dispatch

The Producer shall maintain reasonable communications with Dispatch. For instance, telephone service at an attended Generating Facility or if the facility is remote or unattended, contact information shall be provided for a 24/7 on call representative. For each Generating Facility, 20 MW or greater), an operating agreement shall be mutually developed (between the Generating Facility, CAISO and Valley Electric) to facilitate scheduled and forced operating activities between Parties.

8.4.1 Daily Capacity and Energy Reports

A Producer plant whose rating is 10 MW or more, must provide data via telemetry to the CAISO according to the CAISO Tariff. Valley Electric may also require similar telemetry of data. When such telemetering is inoperative, the facility operator may need to provide data to Dispatch while their telemetering is inoperative.

8.4.2 Voltage Control Operation and Other Service Requirements

Before the Generating Facility can operate automatic voltage control (i.e., generator controls, shunt capacitors) it requires approval by Dispatch and must be in accordance with the provisions of applicable agreements, applicable tariff(s), CAISO requirements and other electric service schedules. The Producer is responsible for the safe operation and interruption and de-energization of the generator-owned voltage control devices.

If the Generating Unit's voltage or power factors, at the point of interconnection, are outside VEA specified values, Valley Electric shall have the right to order a reduction or increase in output, or to disconnect the Generating Unit from the grid if the plant's operation is adversely affecting the VEA electric system.

If the Producer is participating in any interruptible service schedule, the Generating Facility operator must be capable, through additional equipment, of controlling generation to respond to system or local load conditions or system frequency deviations or other direct or automatic control from the CAISO.

8.4.3 Out of Service Relays

Whenever primary relays or protective devices are out of service, backup or secondary relays must be available to clear faults. If the backup relays malfunction, the Producer must provide a designated representative in readiness to manually perform necessary operations. When restoring any relays that have been out of service, the Generating Facility designated representative shall verify that the contacts of any such relays, which are normally open, are in fact open. The Generating entity must ensure that relays do not have standing trip output. Note: The CAISO may have additional requirements for systems designated as CAISO Grid Critical Protective Systems. Refer to the CAISO Tariff available on the CAISO website (www.caiso.com).

8.4.4 Generator Separation and Re-Paralleling

Dispatch may approve automatic re-paralleling of solar, wind and storage generation since these facilities already operate intermittently. For other types of generation, the Producer's designated representative shall notify Dispatch prior to paralleling or separating from the VEA system. For unexpected separations, the Producer's designated representative will inform Dispatch of the nature of the problem (e.g., over-voltage, under-frequency, ground fault, remedial action) and report on any relay target operations. For safety and reliability, a mutually developed set of operating procedures between Valley Electric and the Producer must be documented prior to paralleling and before the facilities connecting the generator to VEA transmission facilities is energized.

8.5 **Interruption Events**

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 VEA facilities. After experiencing an event, the Producer is required to timely submit the following event information to Dispatch in order for Valley Electric 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.

8.6 **Unusual or System Emergency Conditions**

For all System Emergencies, the CAISO is responsible for managing the emergency and for restoration as specified in the CAISO Tariff. All Generating Units and System Resources that are owned or controlled by a Participating Generator are (without limitation to the CAISO's other rights under the CAISO Tariff) subject to control by the CAISO during a System Emergency and in circumstances in which the CAISO considers that a System Emergency is imminent or a threat. The CAISO shall, subject to applicable CAISO Tariff provisions, have the authority to instruct a Participating Generator to bring its Generating Unit on-line, off-line, or increase or curtail the output of the Generating Unit and to alter scheduled deliveries of Energy and Ancillary Services into or out of the CAISO Controlled Grid, if such an instruction is reasonably necessary to prevent an imminent or threatened System Emergency or to retain Operational Control over the CAISO Controlled Grid during an actual System Emergency. Valley Electric is responsible for complying with all directions from the CAISO regarding management and alleviation of the System Emergency, unless such compliance would impair the Health and Safety of personnel or the general public. As directed by the CAISO, Valley Electric will be responsible for communicating with Generating Facilities regarding emergencies. Unusual operating conditions or other factors that have affected or may affect the CAISO Controlled Grid or VEA's electric system (e.g., abnormal voltages or loading or unbalanced loading) must be reported to Dispatch as soon as possible. Conditions imperiling life or property shall be reported to Dispatch immediately. T Dispatch shall be notified of any forced outage. Dispatch shall notify the Producer of any unusual CAISO Controlled Grid or VEA conditions that may affect the Producer's facility. During any emergency, the facility operator shall follow the instructions of Dispatch.

8.7 **Replacement, Modification or Removal of any Interconnection Facilities**

The Generating Facility operator shall notify Dispatch of any replacement, modification or removal of any interconnection facilities:

- Transformer, breaker,
- Changes in EMS/SCADA, (Emergency Management System/Supervisory Control and Data Acquisition),
- Disconnects, relays, and special protection equipment, including RAS.

For the Interconnection Facilities listed above, the Generating Facility operator shall follow the manufacturer's minimum maintenance requirements on file for audit by Valley Electric's Engineering Manager.

- Results of four-year bench tests on all VEA-required relays.
- Results of recommended maintenance tests on interconnection circuit breakers and transformers.

The Generating Facility operator shall notify Dispatch:

- The time of any relay operations and targets of the relay that caused the Generating Facility to separate unexpectedly.
- The time of any unexpected paralleling with and separations from the VEA system.

- The time of the change in voltage-control device set points (if applicable) and the time of change in the operating status (i.e., opened or closed) of any other voltage-control device (i.e., shunt capacitors or reactors).

8.8 Phasor Monitoring Unit

As a Balancing Authority under NERC reliability standards, the CAISO has an obligation to match (i) the actual dynamic response of the system to disturbances, to (ii) the simulated dynamic response of the system to the same disturbances under similar system conditions. To allow the CAISO to match actual and simulated performance, individual generators larger than 10 MVA, and generating facilities with a maximum facility output equal or greater than 20 MVA are required to provide PTOs with dynamic models that simulate the generator's dynamic response to disturbances on the system.

Under NERC reliability standards, VEA is a PTO within the CAISO Balancing Authority. VEA thereby has an obligation to provide to the CAISO dynamic models that will allow the CAISO to demonstrate a match between actual and simulated dynamic performance. Accordingly, each individual generator that is larger than 10 MVA, or generating facility that has a maximum facility output equal or greater than 20 MVA, shall install and maintain, at its expense, phasor measurement units (PMUs).

These PMUs must be capable of capturing real-time data sufficient to allow VEA to either (i) validate, or (ii) identify errors or inaccuracies in, the dynamic models provided by the Producer to VEA.

PMUs shall be installed on the Producer facility low side of the generator step-up transformer, unless it is a non-synchronous generation facility, in which case the PMUs shall be installed on the Producer facility side of the Point of Interconnection.

Installed PMU must be capable of a minimum of 30 samples per second and synchronized via a high-accuracy satellite clock. Phasor Data Concentrator (PDC) Requirements

PMU equipment which includes the communication circuit should be capable of carrying the PMU data to a local data concentrator, and then transporting the information continuously to VEA, as well as storing the PMU data locally for thirty days.

8.9 Event Recorder

All generation facilities connecting to VEA transmission facilities must have an event recorder that will enable Valley Electric to make an after-the fact determination of the status of the Generating Facility at the time of a system disturbance, should such a determination be required. The events should be recorded to sub-cycle resolution. The Generating Facility shall ensure the time reading is correct and synchronized via a high accuracy satellite clock. The Producer will provide Valley Electric event recorder data timely upon request.

8.10 Required Equipment for Disturbance Monitoring and Reporting – DDR and PMU

Studies indicate most or all generation Customers interconnecting into VEA's service area will participate in one or more Remedial Action Schemes (RAS).

As part of good utility practice, VEA plans to benchmark Bulk Electric System (BES) computer models against real-world events such as RAS operations and BES outages. In support of this goal, VEA requires installation of Dynamic Disturbance Recording (DDR) and Phasor Monitoring Unit (PMU) facilities for all Customers interconnecting into VEA's service area.

VEA's standard requirement is for Customers to use SEL DDR & PMU devices. VEA will coordinate with the Customer during the interconnection process to identify appropriate SEL devices, the infrastructure needed to support such devices and Customer reporting requirements. DDR, PMU devices and associated infrastructure shall be purchased and installed at the Customer's expense.

8.11 Paralleling to and Separating from VEA (Attended Generating Facilities Only)

The Generating Facility designated representative shall notify Dispatch prior to paralleling or separating from the VEA system. For unexpected separations, the Producer designated representative

will inform Dispatch of the nature of the problem (i.e., overvoltage, under-frequency, ground fault, remedial action, etc.) and report on any relay target operations.

8.12 Producer Work-Notices to Valley Electric – Situational Awareness

For situational awareness, Valley Electric requests notifications when the Producer's plant is taken off-line for maintenance or other schedule work. A suggested approach is for the Producer to merely add Valley Electric's Outage Coordinator and Dispatch Desk contacts to those emails the Producer sends to the CAISO as part of the CASIO notification process. In this way, Valley Electric is automatically notified by the Producer of:

1. Initial notice of work to the CAISO,
2. Any change-requests the Producer makes to the CAISO,
3. "Day-of" notice which is the day when the Producers' work will commence and
4. When the work is completed and plant is back in normal operations.

These Producer work-notices will provide Valley Electric and the Producer important situational awareness in which both Valley Electric and the Producer will benefit in a safer operating environment.

8.13 Generator Operating Parameters

The typical operating parameter information Dispatch requires is shown below. Dispatch will coordinate with the Producer exactly what operating parameters they require on a case-by-case basis.

1. Net Maximum operating level MW
2. Net Minimum continuous operating level MW
3. Ramp rate (MW/Minimum), normal and emergency (Load pick-up
4. capability of Generating Unit)
5. Gross MW capability of Generating Unit
6. Time to have Generating Unit prepared to close into bus following notification (minutes). Please provide information for hot, warm and cold starts.
7. Maximum and Minimum reactive capability (MVAR). Provide generator capability curve (D Curve).
8. Step-up transformer modelling and Tap Changer characteristics (NLTC or TCUL, and the different tap positions).
9. Time to reach rated power following synchronization (minutes);
10. Single line diagrams showing connections to the Grid and required switching steps needed to connect to the Grid.
11. Black-start capable (yes/no)
12. Isochronous capability (yes/no)
13. Types of fuel used and onsite storage capacity.
14. WECC dynamic testing results or dynamic testing plan per WECC requirements. Once the WECC dynamic testing has been performed and the required PSLF modeling has been developed, the dynamic model is to be submitted to VEA. Test results must be submitted to VEA within 180 days of beginning commercial operation.

8.13.1 The table below shows typical operational communications

	Generation Facility Record	Typical Size of Generation Facility	Communication Mode	Delivery Location
1	System Parallel or Separation	> 200 kW	Prior to system parallel or separation, by voice	Dispatch

2	Schedule and Unscheduled Outages	> 200 kW	Scheduled Outages: Valley Electric Transmission Outage Coordinator via voice or email Duration — Notice Required <30 minutes — 96 hours >30 minutes — 30 calendar days Major Overhaul — 6 calendar months Unscheduled Outages – Timely by voice	Dispatch
3	Levels of Real and Reactive Power	≥ 1 MW	Real-time telemetering	SCADA
4	Equipment Clearance	≥ 10 MW	Prior to taking equipment clearance, by voice	Dispatch
5	Interruption event	> 200 kW	Timely by voice	Dispatch
6	Gen. Circuit Breaker Status	≥ 10 MW	Real-time telemetering	SCADA
7	Gen. on/off Status	≥ 10 MW	Real-time telemetering	SCADA
8	Generator terminal voltage	≥ 10 MW	Real-time telemetering	SCADA

9. REQUIREMENTS FOR COMMERCIAL OPERATION

9.1 **Purpose**

The purpose of this section is to provide Producers with a general understanding of VEA and some CAISO requirements for parallel operation with the VEA grid.

The Producer must comply with the CAISO's" New resource implementation process and requirements", or NRI. The CAISO requirements are found on their webpage (www.caiso.com) which contains guidelines, deliverables and activities needed during the final 203 days of the project's interconnection. This CAISO process requires the following two letters from VEA to the Producer: (1) Interconnection Approval Letter and (2) VEA Final Approval Letter. These letters originate from VEA, then are sent to NRI by the Producer.

When the Producer successfully completes VEA requirements contained in this handbook or otherwise requested by VEA, VEA will provide the CAISO the aforementioned two letters. If there are no restrictions in VEA's "Interconnection Approval Letter" and the letter approves commercial operation, then it can also be utilized as VEA's "Final Approval Letter" for Producer commercial operations NRI requirements.

9.2 Producer Requirements for VEA Interconnection Approval Letter

CAISO requires an "Interconnection Approval Letter" from VEA in order for the CAISO to grant permission for generator(s) syncing and testing. Before that, VEA requires the Producer provide VEA a "Turn-Over" letter stating their equipment installation and testing is complete, all relay and control systems have been tested between the Producer and VEA, their equipment is ready for service and all other requirements in this section have been completed. The Turn-Over letter will also provide that the Producer is aware, and that their personnel have been informed (and/or trained), that VEA facilities up to their Generating Facilities will be energized.

9.2.1 Test Results and/or Information Required Prior to Syncing and Testing

All tests outlined below must be complete and two (2) copies of test reports submitted to Dispatch a minimum of fifteen (15) business days before the date the Producer wants the Interconnection Approval Letter. Producer's work plan should include that test reports are approved by Valley Electric at least three (3) business days before the date the Producer wants the Interconnection Approval Letter. Failure to meet VEA requirements may result in delay of issuance of the Interconnection Approval Letter, which will delay syncing/testing of Producer's equipment. Also any inspections required by local government agencies must be completed and permits signed off prior to the syncing/testing date.

9.2.2 Proving Insulation

For any of the megger tests referred to below a 2,500-volt DC megger or a hipot is preferred, but a 1,000-volt DC megger is acceptable.

- All transformers connected to the primary bus and the main transformer must be meggered winding to winding and each winding to ground. For purposes of this document, "primary bus" is defined as the source-side bus or conductor from the primary interrupting device to the generating plant.
- All circuit breakers and circuit switchers connected to the primary bus and at the interconnection point must be meggered in the following manner: Breaker open - each pole to ground, pole 1-2, pole 3-4, pole 5-6; breaker closed - pole 1-ground, pole 3-ground, pole 5-ground and if the poles are in common tank or cell, pole 1-3, pole 3-5, pole 5-1.
- All buses and cables shall be meggered phase-to-phase and phase-to-ground.
- The main transformer(s) and main breaker(s) shall have a dielectric test performed on the insulating medium (gas or oil). This does not apply to factory-sealed circuit switcher interrupters.
- The Generating Unit(s) must be meggered or hi-pot tested phase-to-phase and phase-to-ground.

9.2.3 Proving Ratios

All ratios of transformers connected to the primary bus must be proven using either a turns ratio tester or a voltage ratio test. The main transformer must be tested on the final operating tap as determined by Valley Electric.

9.2.4 Circuit Breakers and Circuit Switchers

- A minimum to trip at 70 volts (assuming a nominal 125 VDC battery system) must be performed on all circuit breakers and/or circuit switchers that are operated by VEA-required relays.
- A Micro-Ohm test must be performed on all circuit breakers and circuit switchers.
- A timing test showing the time from trip initiation to main poles opening is required.
- A timing test showing the time from close initiation to main poles closing is required.

9.2.5 Current Transformers and Current Circuits

- A saturation check must be made on all current transformers (CTs) associated with the required VEA relays.
- The ratio of all CTs must be proven.
- CT circuits must be checked for proper connections and continuity by applying primary or secondary current and reading in the relays. Each test (primary or secondary) must be performed

in all combinations to prove proper connections to all phase and ground relays. Current must be applied or injected to achieve a secondary reading of 0.5 amps in each relay to ensure that no loose wiring or parallel current paths exist.

A check of the total circuit with the ground wire lifted must be done to prove that only one ground exists.

9.2.6 Relays

All relays must be field tested on site to their specified settings to verify the following:

- Minimum operating point at which relay picks up (minimum pickup).
- Time delay at three different current test points, in integral multiples of minimum pickup that closely characterize the relay time-current curve.
- Phase angle characteristic of directional relay.
- Pickup points at maximum torque angle (MTA) and 30 degrees of MTA on impedance relays using the approved settings.
- Slip frequency, voltage matching, phase angle acceptance and breaker compensation time on synchronizing relays.

VEA tolerances are listed below:

- Current/Voltage/Time + 3 to 5 percent
- Impedance/Phase Angle + 0.05 degrees
- Frequency + 0.05 Hz

If a pilot relay system is required by VEA, signal level checks must be performed.

9.2.7 Primary Disconnect Switch

The primary disconnect switch at the point of interconnection shall be clearly labeled and lockable in the open position.

9.2.8 Real-Time Device

The final remote Real-Time Device database shall be provided to Valley Electric at least thirty (30) calendar days prior to scheduled commercial operation date.

9.2.9 Metering Inspection

Subsequent to Valley Electric Engineering approval of the metering design, Valley Electric shall be provided at least thirty (30) business days' notice to perform an inspection of the facility. This inspection includes, but is not limited to, verifying wire impedances, ratio checking of CT's, and inspecting the metering cabinet and associated hardware. Upon a satisfactory inspection by Valley Electric of the facility, the VEA meters and ancillary equipment shall be installed by Valley Electric. The facility may not be energized before the installation of the VEA meters.

9.2.10 Station Battery

When a battery is installed, proof of discharge testing is required to ensure that the battery has the capacity to support the load and trip.

9.2.11 Pre-Parallel Test

The Producer is responsible for ensuring that all relays, data telemetry and other protective devices are adjusted and working properly prior to the pre-parallel inspection. If problems arise with equipment during testing, the Valley Electric protection representative may elect to cancel the test and reschedule. All pre-parallel tests should only be scheduled to begin at 8:00 AM and completed by 6:00 PM Monday through Friday. Functional tests shall be performed by the Producer and all tests shall be observed by Valley Electric as outlined below. The Producer shall provide all test equipment and qualified personnel to perform the required tests. Valley Electric shall be included strictly as an observer.

9.2.12 Functional Tests

The following functional tests shall be performed after the equipment has been energized, but before the Generating Unit is paralleled with VEA's grid:

- Check that each protective relay trips the appropriate generator breaker and/or main breaker. This may require injecting a signal. Jumpering across a contact on the back of the relay is not acceptable.
- When first energized, check that proper secondary potential is applied to all voltage and frequency relays.
- Check the synchronizing meter, synchronizing equipment and phasing panel (if used) with the paralleling breaker closed and the generator off-line. This typically requires lifting the generator leads. The equipment should show an "in-phase" condition.
- Check the generator phase rotation. (VEA's phase rotation is C-B-A) phasing tool or a phasing panel provided by the Generator. The synchronizing equipment typically checks one phase only. Any other method of demonstrating correct phasing and phase rotation shall be approved by Valley Electric in writing prior to conducting the test. Alternative methodologies to check phasing and phase rotations must be submitted to Valley Electric fifteen (15) business days in advance of scheduled pre-parallel test. Valley Electric must approve the methodology three business days in advance of pre-parallel test date.

9.2.13 Impedance and Directional Relay Tests

Direction-check all impedance and directional relays.

9.2.14 Producer Load Tests

For Producers, the following load tests shall be performed after the Generating Unit picks up load:

- Verify operation of the Generating Unit at 95 percent lagging power factor and at 95 percent leading power factor at rated output.
- Verify operation of the Generating Unit at 95 percent and 105 percent of per unit voltage while delivering rated output.
- Load check all VEA required differential relays. The load current must balance to zero in all differential relays.
- Load check voltage restraint over-current relays to prove correct connection of currents and potentials.
- The Generating Unit(s) may have to be paralleled temporarily with VEA’s system to run the load tests. Permission to do this shall be given by the Valley Electric representative observing the test and coordinated with Dispatch.

9.2.15 Data Telemetry Tests

Dispatch must verify the following prior to Pre-Parallel Operations.

- Communications circuits meet specifications and are functioning properly.
- Real-Time Device data is mapped correctly to VEA SCADA systems.
- Scaling on all analog data points is correct.
- Point to Point check on all status points is verified at Dispatch.

Typically, pre-parallel inspections can be performed within a normal working day. If a test cannot be completed by 6:00 PM, the Valley Electric representative may cancel the remainder of the test and reschedule it. In this case, the Generating Entity shall incur additional costs for the pre-parallel inspection.

9.2.16 Model Testing and Validation Report

VEA utilizes WECC guidelines which require generation equipment be tested in order for utilities to verify computer models of such equipment. Producer data submitted to VEA for computer steady-state and dynamics modeling used in planning and operating studies must be consistent with the actual physical characteristics of the Producer’s equipment. The Producer shall report to VEA the following data to verify

computer models: generator gross and net dependable capability, gross and net reactive power capability, voltage regulator controls, speed and/or load governor controls and excitation systems.

9.3 VEA Final Approval Letter

The Producer may require a Final Approval Letter from VEA before the Producer requests a final Commercial Operation Date with the CAISO. The Final Approval Letter will clearly state VEA is giving the Producer permission to commence commercial operation at a specific MW capacity. Note, a final letter may not be required if the Interconnection Approval Letter has already granted the Producer both testing and commercial operation.

If a Final Approval Letter is required, then the Producer shall certify in writing to VEA at least ten (10) business days before their Commercial Operation Date that it has met all VEA requirements.

9.4 General Notes

- The VEA system has C-B-A clockwise rotation.
- Any changes to VEA-required protection equipment or major substation equipment (e.g., transformers and breakers) must be submitted to Valley Electric for review and approval by the appropriate Valley Electric engineer prior to the changes being made.
- Routine maintenance on VEA-required protective relays and the breaker(s) must meet VEA's maintenance and test practices. After completion of these tests, test reports must be submitted to Valley Electric (protection specialist) for review and approval by the appropriate Valley Electric engineer.
- A Valley Electric technical representative shall then come to the Producer's Generating Facilities and verify the settings.

10. POWER QUALITY

10.1 Purpose

The purpose of this section is to provide Producers with a general understanding of applicable VEA power quality requirements.

10.2 Experimental Generation

Typically, all Generating Units must meet all applicable ANSI and IEEE standards. Further, Generating Systems not meeting these standards or not certified by recognized by Boards or laboratories, such as UL, may be considered experimental. To protect power quality and the integrity of VEA's grid, experimental generation may not be interconnected to any VEA facility.

10.3 Voltage Imbalance

The unbalanced voltage level (magnitude and phase), due to a generator facility connected at the transmission system level, may not exceed 1% at the Point of Common Connection (PCC), under steady state system conditions. Under certain conditions (contingency conditions), Valley Electric may allow higher levels of voltage imbalance if justified after a study conducted by VEA. In any event, the unbalanced voltage level created by a generator facility shall not exceed 1.5%.

It is the responsibility of Producers, with a generator facility connected to VEA's electric system to install adequate mitigation devices to protect their own equipment from damage that maybe caused by voltage imbalance condition.

10.4 Voltage Fluctuation Limits

A generator connected to the VEA system must not cause harmful voltage fluctuations or interference with service and communication facilities. Any generation facility that does so is subject to being disconnected from the VEA system until the condition has been corrected.

10.5 Photovoltaic Inverter Systems

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 VEA's Requirements for voltage imbalance and abnormal waveforms.

10.6 Harmonics

Producers 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.

Under IEEE Standard 519, the Generating Entity is responsible for operating its facilities and equipment to avoid unacceptable interference which may adversely affect VEA's operations or service provided to other Producers, whether by voltage fluctuations, harmonics, or inductive interference. As an example, total voltage harmonic distortion may not exceed 5 percent. The Producer is responsible for the costs of mitigating any interference it causes.

10.6.1 Harmonic Limits

Generally, total voltage harmonic distortion may not exceed 5 percent. All Producers shall comply with the voltage and current harmonic limits specified in IEEE Standard 519-1992, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems".

Producer harmonic problems shall be handled on a case-by-case basis. A generation facility causing harmonic interference is considered by VEA as a serious interference with service and is subject to being disconnected from the VEA system until the condition has been corrected.

If the cause of the problem is traceable to the Producer's facilities, all costs associated with determining and correcting problems shall be at the Producer's expense.

Many methods may be used to restrict harmonics. The preferred method is to install a transformer with at least one delta connection between the generator and the VEA system. This method significantly limits the amount of voltage and current harmonics entering the VEA system. Generation system configuration with a star-grounded generator and a two-winding (both star-grounded) transformer shall not be allowed.

10.7 Voltage Ride-Trough Requirements

VEA currently follows the Low Voltage Ride-Through Criteria that WECC has adopted to ensure continued reliable service. Producers shall comply with WECC ride-through criteria.

More information on voltage ride-through requirements is available at the WECC website.

Also, more information on voltage ride-through issues associated with alternative technologies can be found on the FERC website: http://www.ferc.gov/industries/electric/indus-act/gi/wind.asp

10.8 RMS Voltage

A Producer connected to VEA transmission facilities shall not cause RMS voltage to exceed the Maximum Service Voltage allowed per ANSI C84.1-2011, Table 1, Voltage Range A, where RMS voltage is defined as the average voltage over a 10-minute interval.

10.9 Voltage Flicker Criteria

Random voltage fluctuations (flicker) occurring at the POI directly attributable to the Producer shall remain within the limits specified in latest revision of IEEE Standard 1453 ("IEEE Recommended Practice for the Analysis of Fluctuating Installations on Power Systems"). Under no circumstances will a Producer permit voltage flicker to exceed VEA's voltage flicker criteria as set forth in the preceding sentence. This obligation exists whether or not complaints are received or service/operational problems are experienced on the VEA Grid. Should complaints be received by the Valley Electric or should other operating problems arise, or should the Producer flicker exceed the VEA criteria, the Producer agrees to take immediate action to reduce its flicker to a level at which flicker complaints and service/operational

problems are eliminated. Corrective measures could include, but are not limited to, modifying production methods/materials or installing, at the Producer's expense, voltage flicker mitigation equipment such as a static DVAR, VAR compensator or another device. Valley Electric will work collaboratively with the Producer to assess problems, identify solutions and implement mutually agreed corrective measures.

VEA will take corrective action as allowed by law, tariff or regulation, which may include discontinuing service, until such time as the problem is corrected

10.10 Under-Frequency Operating Requirements (PRC-024-2)

All Producers greater than 10 MW connecting to the grid must conform with NERC Standard PRC-024-2 and disclose the same information provided to WECC to VEA.

10.10.1 Low/High Voltage Ride-Through (LHVRT) and Low/High Frequency Ride-Through (LHFRT) Capability – all inverters

Actual fault events have demonstrated that certain asynchronous generators (i.e., inverters) from specific manufacturers may be susceptible to false tripping or temporary shutdown during fault conditions. The most severe disturbance to date resulted in the temporary loss of 1,178 MW at photovoltaic plants when inverter control systems throughout Southern California responded to a 500 kV fault by temporarily stopping the production of electric power. Based on the results of an investigation performed into this issue, several causes and contributing factors have been identified which include:

a) Apparent miscalculated frequency at many inverters when fault-induced phase shifts occurred in the reference voltage
b) Inverter protection settings set to meet IEEE 1547 standards
c) Momentary overvoltage
d) Momentary under-voltage

The NERC PRC-024-2 standard currently allows generators to instantaneously trip if the system conditions are outside of a defined set of bounds. Because different inverter manufacturers use different methods to calculate frequency (zero crossing, DFT, PLL, etc), the methods used by some manufacturers have resulted in calculations of the instantaneous frequency during power system disturbances that do not accurately reflect actual frequency. Inaccurate frequency calculations may result in the reduction of electric power from inverter-based resources which is an unacceptable response. In addition, voltage transients caused by capacitive switching (among other potential causes) can cause inverters to trip due to a momentary overvoltage conditions which too is an unacceptable response unless the Project has reached the power factor lead (buck) limits and the voltage is still in excess of the maximum allowable voltage limit for a duration longer than the no trip timer defined in PRC-024-2.

When under-voltage occurs during the fault, some inverters may cease operation temporarily. Such performance may not be allowed in the future reliability standards/interconnection standards.

The Customer should work with the inverter manufacturer to ensure that the project's inverters meet the requirements of NERC Standard PRC-024 and conform with the NERC advisory issued on June 20, 2017:

http://www.nerc.com/pa/rrm/bpsa/Alerts%20DL/NERC%20Alert%20Loss%20of%20Solar%20Resources%20during%20Transmission%20Disturbance.pdf

This NERC advisory is required to be followed by all inverter based generation connected to the CAISO controlled grid.

10.10.2 The WECC Off-Nominal Frequency Load Shedding Plan requires that Producers connected to the grid that protect for off-nominal frequency operation have relaying protection that accommodates, as a minimum, under-frequency and over-frequency operation for specific time frames. The requirement is shown below. VEA provides this table for information purposes only. The requirement may be changed from time-to-time. Please check with the WECC for updates.

WECC Off-Nominal Frequency Limits		
Under-frequency Limit	Over-frequency Limit	WECC Minimum Time
> 59.4 Hz	60 Hz to < 60.6 Hz	N/A (Continuous Operation)
≤ 59.4 Hz	≥ 60.6 Hz	3 minutes
≤ 58.4 Hz	≥ 61.6 Hz	30 seconds
≤ 57.8 Hz		7.5 seconds
≤ 57.3 Hz		45 cycles
≤ 57.0 Hz	> 61.7 Hz	Instantaneous trip

11. OTHER REQUIREMENTS

11.1 Right of Way Requirements

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

11.2 Transmission Line Crossing Policy

A "proposed" Interconnection Transmission line, or Rights of Way Access, crossing VEA Transmission line or Access easements or fee owned property must be submitted to VEA for review and approval. For your reference, below are generally VEA's Transmission Crossing Policy guidelines:

- A new non-VEA owned transmission line of equal or lower voltage shall not be allowed the superior position and will cross under the existing VEA Facilities and/or the new facilities proposed prior to the new line, including facilities needed for queued-or-clustered-ahead generation.
- A new non-VEA owned transmission line, triggered by a Producer facility, with higher voltage may be allowed the superior position than a VEA line if it has a self-supporting Dead-end construction, and has a minimum of double insulator strings on both sides. VEA will regain the superior position if its lower voltage facilities are upgraded and are of equal or higher voltage than the non-VEA owned transmission line.
- A new non-VEA owned transmission line of higher voltage may be allowed the superior position if it crosses a multiple VEA circuit corridor (two circuits or more). However, this type of crossing needs to be reviewed, and approved by VEA on a case-by-case basis.

11.3 Specific Facility Requirements

The Producer shall ensure that its transmission facilities are constructed to good engineering practice and standards including National Electric Safety Code standards. Where facilities are intended to be owned by VEA, additional design requirements apply and must be consistent with VEA's design standards.

11.4 Wind turbine safety setback

Except for Producer tap lines, a minimum safety setback from VEA transmission lines of three times the total turbine height, with a blade in vertical position, from the edge of Company facility shall be maintained. If a greater safety setback is required by any local government authority, then the greater safety setback shall be observed.

11.5 **Transmission Taps**

Generally, VEA does not tap its transmission lines. Transmission taps will be approved by VEA on a case-by-case basis. Typically, transmission lines are interconnected by a new 3-ring bus substation or a breaker-and-a-half position at an existing substation.

11.6 **Signage for Facilities Accessed by Valley Electric Personnel**

Some Producer facilities may be accessed by Valley Electric personnel. The Producer shall coordinate with Valley Electric on appropriate signage and component identification numbers if applicable. Generally, Valley Electric signage meets NESC and ANSI Z535 Safety Sign Standards for Electric Utility Power Plants and Substations.

12. VEA CONTACT INFORMATION

Typically, VEA will assign a single point to coordinate information between VEA and Producers during an initial meeting with the Producer. The single point of contact should be part of all communication, but as a project develops sometimes other employees may interface directly with the Producer. VEA will provide the Producer direct VEA contacts during an initial meeting and later when needed.

13. DEFINITIONS

- Terms used in this document are defined in the CAISO master definition supplement list located at the CAISO website.
- The CAISO internet home page at http://www.caiso.com or such other internet address as the CAISO shall publish from time to time.
- CAISO - The California Independent System Operator Corporation, a state chartered, California non-profit public benefit corporation that operates the transmission facilities of all Participating TOs and dispatches certain Generating Units and Loads.
- CAISO Operations Date - March 31, 1998.