Requirements
For
Generator Interconnection

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This document is to be used as only a general guideline of specific interconnection requirements. In developing this document, Idaho Power Company has reviewed and incorporated various electrical codes and regulations, safety codes and regulations, prudent electrical practices, utility codes and regulations, Federal and state regulations, and the Idaho Power Company system impact. In the event any statements or interpretations within this document are inconsistent with the various governing standards and codes, the standards and codes will govern. Idaho Power Company reserves the right to update, correct and/or modify these Interconnection Requirements without notice.

December 2007

IDAHO POWER COMPANY

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PART 1 GENERAL

1.1. Introduction

This guideline describes the minimum requirements for safe and effective operation of generation on The Idaho Power Company (IPC) system. The generation owner (Generator) and IPC personnel will be guided by this document when planning installations of generation interconnected with the IPC system. **It is emphasized that these guidelines are general and may not cover all details in specific cases. Additional requirements not found in the document may be necessary as a result of the findings of a system impact study for a specific project.**

IPC will permit any Generator to operate generating equipment in parallel with IPC's electric system whenever this can be done without adverse effects to the general public or to IPC equipment and personnel. Interconnections to the IPC system may be made at the transmission or distribution level consistent with IPC's Open Access Transmission Tariff (OATT) filed with the Federal Energy Regulatory Commission (FERC). Generators can initiate Idaho Power Company's Generator Interconnection process by applying for interconnection under the OATT. For more information, go to IPC's Generator Interconnection information website .

Certain interconnection equipment (disconnects, relays, circuit breakers, meters, communications, etc.) must be installed where a Generator desires to operate generation in parallel with the IPC system. In general, Figure 1.1 summarizes these requirements. Specific requirements of the Generator's generation equipment are specified herein.

Figure 1-1

SUMMARY OF INTERCONNECTION REQUIREMENTS[1]

Interconnection Equipment[2]	25-kVA or less	25-kVA to 100-kVA	100-kVA to 1-MVA	More than 1-MVA
Dedicated Transformer	X[3]	X[3]	X	X
Revenue Metering[4]	X	X	X	X
Disconnect Device[9]	X[6]	X[6]	X[6]	X[7]
Circuit Interrupting Device[13]	X[5]	X[5]	X[8]	X[7]
Over/Under Voltage Protection (59/27)[13]	X[5]	X[5]		
Over/Under Frequency Protection (81O/81U)[13]	X[5]	X[5]		
Multifunction Relay[10, 12]			X	X
Telemetry[11]				X

[1]All requirements are based on generator nameplate, unless otherwise indicated.

[2]The equipment listed fulfills only the minimum requirements necessary to protect IPC and its customers. Additional equipment may be required to ensure adequate protection based on the factors discussed herein.

[3]In general, generators less than 100-kW generating at a secondary voltage level may not require a dedicated transformer. However, this must be approved by IPC after review of the project details.

[4]IPC will own the revenue meter. If IPC owns the dedicated transformer, the meter will be located on the low-voltage system (transformer secondary side). If the Generator owns the dedicated transformer, the meter will be located on the high-voltage system (transformer primary side).

[5]Generator may own, install, and maintain on the low-voltage system (transformer secondary side).

[6]If IPC owns the dedicated transformer, this device may be owned, installed, and maintained by the Generator on the low-voltage system (transformer secondary side). If the Generator owns the dedicated transformer, this device shall be owned, installed, operated and maintained by IPC on the high-voltage system (transformer primary side).

[7]IPC owned, installed, operated, and maintained.

[8]Generator may own, install, and maintain on the low-voltage system (transformer secondary side). The device shall be capable of being remotely tripped by IPC.

[9]Additional disconnect devices will be required for electrical isolation of interconnection facilities for maintenance. The additional disconnect devices will be considered as network upgrades.

[10]IPC owned relay(s) that performs multiple protection functions that include, but not limited to, over/under voltage, over/under frequency, ground fault protection, overcurrent with voltage restraint or voltage restraint/voltage control overcurrent, phase directional overcurrent, out of step, etc.

[11]Requirement is based on deliveries to IPC, not necessarily generator nameplate rating. Telemetering for net power output may be required based on interconnection agreement and contractual arrangements for generation output.

[12]An IPC owned dedicated DC power supply (battery or UPS) is required for all generation projects larger than 300-kW.

[13]Non-islanding DC inverters meeting the requirements of IEEE 929 and UL 1741 may have these functions incorporated in, or integral, to the DC inverter package.

In general, commingling of load and generation downstream of an interconnection point is not allowed unless the Generator qualifies under Net Metering tariff, or other contractual arrangements (facilities charges, standby power contracts, etc.) are established.

IPC shall have the right to review the design of a Generator's equipment and interconnection facilities and to inspect the facilities prior to commencement of parallel operation with IPC's electrical system. IPC may require a Generator to make modifications as necessary to comply with the requirements of this document. IPC's review and authorization for parallel operation shall not be construed as confirming or endorsing the Generator's design or as warranting the generation and interconnection facilities' safety, durability, or reliability.

IPC's minimum requirements are designed and intended to protect IPC from damage. IPC will not assume any responsibility for protection of the Generator's generator(s) or of any other portion of the Generator's equipment. The Generator is fully responsible for protecting its equipment in such a manner that faults or

other disturbances on the IPC system do not cause damage to the Generator's equipment. In addition, the Generator is fully responsible for protecting the IPC system and its customers from damage due to operation of the Generator's facilities. Use of these guidelines and specifications does not relieve the Generator of any liability or obligations. In the event of any damage or injury as a result of the operation of the Generator's generation either at the Generator's location or any location in the IPC system, the Generator will be liable for all such damages or injury.

Throughout this document, generation size is addressed on the basis of volt-amperes (VA) or kilovolt-amperes (kVA) rather than watts or kilowatts (kW). However, for generation projects of 25-kVA or smaller, the rating of equipment is often provided to IPC from the Generator in watts or kilowatts. Such ratings will be considered equivalent of the same rating in volt-amperes or kilovolt-amperes since the power factor of the generation equipment may be unknown (e.g. 25-kW ~ 25-kVA)

1.2. Responsibilities of the Generator

The Generator is responsible for the following as part of the review, design, and construction of the generator interconnection:

- Design, installation, operation and maintenance of his own equipment in accordance with all applicable federal, state, electrical, and safety codes as well as prudent electrical utility practices.
- Obtaining the necessary permits and inspections required by the federal, state, and local authorities having jurisdiction over the generation project.
- Submitting specifications for the generation equipment and specifications/control schematics for the Generator-provided interconnection protection and control devices to IPC for review and written approval prior to parallel operation. Note: Written approval by IPC does not indicate or ensure acceptance by local code authorities.
- Providing access for IPC to Generator owned facilities for switching, dispatching, inspection, and other required operations needs.
- Complying with the requirements as specified herein.
- Reimbursing IPC for all expenses (labor, mileage, equipment, overheads, etc) incurred to review, design, construct or any other function required to enable the installation and interconnection of the Generator's generation facility.

1.3. Generation System Operation

The Generator may elect to run its generator in parallel (interconnected) with IPC or as a separate system with the capability of nonparallel load transfer between the two independent systems. The two methods of operation are outlined below.

1.3.1 Separate System

A separate system is one in which there is no possibility of delivering energy to the IPC system from the Generator's equipment. For this operation to be practical the Generator may want to maintain the capability of transferring load between the two systems, but such transfer must be accomplished in an open transition or nonparallel mode. This can be accomplished by either an electrically or mechanically interlocked switching arrangement, which precludes operation of both switches in the closed position simultaneously.

If the Generator has a separate system, IPC will require verification that the transfer scheme meets the nonparallel requirements. This will be accomplished by review and approval of drawings and equipment specifications by IPC, and if IPC so elects, by field inspection of the transfer scheme. IPC will not be responsible for approving the Generator's generation equipment and assumes no responsibility for its design or operation.

1.3.2 Parallel System

A parallel system is one in which the Generator's generation equipment can be connected to IPC's system resulting in a transfer of power between the two systems. A consequence of such parallel operation is that the parallel generator becomes an electrical part of the IPC system, which must be considered in the operation and protection of IPC's facilities.

The general and specific requirements for parallel generation installations are discussed in the following sections.

PART 2 DEFINITIONS

Acceptance Test - A test performed or witnessed once for a specific protection package or device to determine whether specified requirements are met.

ANSI - American National Standards Institute

Automatic Disconnect Device - An electronic or mechanical device used to isolate a circuit or piece of equipment from a source of power without the need for human intervention.

Circuit - A conducting part through which an electric current is intended to flow.

Circuit Interrupting Device - A device designed to open and close a circuit by non-automatic means and to open the circuit automatically as a result of a system excursion without damage to itself when properly applied within its rating.

Cogeneration - The sequential production of electricity and heat, steam, or useful work from the same fuel source.

Coordinated Interconnection Review - Any studies performed by utilities to ensure that the safety and reliability of the electric grid with respect to the interconnection of distributed generation as discussed in this document.

Dedicated Transformer - A transformer that provides electrical service to only one customer. The customer may or may not have a generation facility. Note: "Dedicated" does not imply de facto ownership or exclusive use by the Generator.

Direct Transfer Trip - Remote operation of a circuit interrupting device by means of a communication channel.

Disconnect (verb) - To isolate a circuit or equipment from a source of power. If isolation is accomplished with a solid-state device, "Disconnect" shall mean to cease the transfer of power.

Disconnect Device - A mechanical device used for isolating a circuit or equipment from a source of power.

Dispatchability - The generating facility is operable and can be called upon at any time to increase its deliveries of capacity to any level up to the contract capacity.

Disturbance - Trouble on the electrical system normally referring to fluctuation of frequency or voltage values.

Electric Generator - A machine or device that transforms energy (solar, mechanical, etc.) into electrical power.

Energy Conversion Device - A machine or solid state circuit for changing direct current to alternating current or a machine that changes shaft horsepower to electrical power.

Energize - To apply voltage to a circuit or piece of equipment.

Equipment - A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation.

Fault –An electrical short circuit between elements of potential difference.

Feeder –All circuit conductors between the utility distribution substation, or other power supply source, and the final point of interconnection with a customer or Generator.

Forced Outage – Any electrical outage resulting from a design defect, inadequate construction, operator error or a breakdown of the mechanical or electrical equipment that fully or partially curtails the electrical output of the generating facility.

Frequency – The number of cycles occurring in a given interval of time (usually on second) in an electric current. Frequency is commonly expressed in Hertz.

Generating Facility - the Interconnection Customer's device for the production of electricity identified in the Interconnection Request, but shall not include the Interconnection Customer's Interconnection Facilities.

Ground - A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth (zero potential), or to some conducting body that serves in place of the earth.

Hertz - The term denoting cycles per second or frequency.

IEEE - Institute of Electrical and Electronics Engineers, Inc.

Interconnection - The physical electrical connection that allows the transfer of electrical energy between a generating facility and the utility.

Interconnection Customer – any entity, including the Transmission Owner, or any of its Affiliates or subsidiaries, that proposes to interconnect its Generating Facility with Idaho Power's electrical system.

Interconnection Equipment - The equipment required by prudent electrical utility practice and applicable electrical and safety codes to interconnect, operate, and safely deliver energy from the Generator to the utility system.

Interconnection Request – an Interconnection Customer's written application, under Idaho Power's OATT, to interconnect a new Generating Facility, or to increase the capacity of, or make a Material Modification to the operating characteristics of, an existing Generating Facility that is interconnected with Idaho Power's electrical system.

Islanding - A condition in which a portion of the IPC system that contains both load and distributed generation is isolated from the remainder of the IPC system.

Kilovolt (kV) - An electrical unit of potential that equals 1,000 volts.

Kilovolt-Amperes (kVA) - The product of kilovolts and amperes that defines equipment and/or circuit ratings.

Kilowatt (kW) - An electrical unit of power that equals 1,000 watts

Kilowatt-hour (kWh) - 1,000 watts of energy supplied for 1 hour.

Megawatt (MW) - An electrical unit of power that equals 1,000,000 watts.

Maintenance Test - A test performed upon initial installation and repeated periodically to determine that there is continued acceptable performance.

Material Modification – those modifications that have a material impact on the cost or timing of any Interconnection Request with a later queue priority date.

Nameplate Rating - Output rating information appearing on a generator nameplate in accordance with applicable industry standards.

NEMA - National Electrical Manufacturers Association

NERC - North American Electric Reliability Corporation or its successor organization.

Network Upgrades - Those additions, modifications, and upgrades to Idaho Power's electrical system required at or beyond the point at which the Interconnection Facilities connect to Idaho Power's electrical system to accommodate the interconnection.

Open Access Transmission Tariff (OATT, Tariff) – Idaho Power Company's FERC-approved tariff through which open access transmission service and Interconnection Service are offered.

OSHA - Occupational Safety & Health Administration

Outage - A condition existing when a circuit is de-energized.

Overload - A load in amperes greater than an electric device or circuit is designed to carry or operate.

Overvoltage - Voltage higher than that desired or for which equipment is designed.

Parallel - To electrically connect a generator or energized source, operating at an acceptable frequency and voltage, with an adjacent generator or energized system, after matching frequency, voltage, and phase angle.

Parallel Operation - The operation of a non-utility generator while connected to the utility's grid. Parallel operation may be solely for the Generator's operating convenience or for the purpose of delivering power to the utilities grid.

Point of Interconnection - The point where the Generator's facilities physically connect to Idaho Power facilities (point of ownership change).

Power - The time rate at which electrical energy is emitted, transferred, or received; usually expressed in watts.

Power Factor - The ratio of actual power to apparent power.

Power System Stabilizer or PSS - A control system applied to a generator that monitors generator variables such as current, voltage, and shaft speed and sends the appropriate control signals to the voltage regulator to damp system oscillations.

Primary - Normally considered as the high voltage winding of a substation or distribution transformer.

Protection Equipment – Circuit interrupting device, protective relaying, and associated instrument transformers (if applicable).

Prudent Electrical Practices – Those practices, methods, and equipment, that are commonly used in prudent electrical engineering and operations to design and operate electrical equipment lawfully and with safety, dependability, efficiency, and economy.

Radial Feeder - A distribution line that branches out from a substation and is normally not connected to another substation or another circuit sharing a common supply.

Relay – A device that is operative by a variation in the condition of one electric circuit to affect the operation of another device in the same or in another electric circuit.

Secondary – The winding of a transformer that is normally operated at a lower voltage than the primary winding.

Self-Excited – An electric machine in which the field current is secured from its own armature current.

Synchronism – Expresses the condition across an open circuit wherein the voltage sine wave on one side matches the voltage sine wave on the other side in frequency and without phase angle differences.

System – The entire generating, transmitting, and distributing facilities of an electric company.

System Operator – A generic term used to describe the individuals responsible for the integrity or the operational control of the Transmission Owner's System and any successor thereto.

Transmission Owner's System – The integrated system of electrical generation, transmission, and distribution facilities, and all equipment and facilities ancillary thereto, owned and/or operated by the Transmission Owner.

UL – Underwriters Laboratories

WECC – Western Electric Coordinating Council

PART 3 DESIGN REQUIREMENTS FOR PARALLEL SYSTEM OPERATION

3.1. General Requirements

IPC is required to follow certain safety procedures and maintain specified service limits of voltage, frequency, flicker, harmonic distortion, fault protection, and surge capability of the IPC system. The introduction of a parallel generator represents additional constraints that present several concerns and additional responsibilities for IPC that cannot be delegated to others:

3.1.1 Personnel Protection: IPC operating personnel need to be aware of the exact location of all generation sources and appropriate action taken to isolate them before beginning work on a circuit. IPC safety procedures (in accordance with OSHA) require that a visible and lockable disconnect device be provided at all electrical sources to ensure that a circuit is not inadvertently energized. In addition, proper grounding is required to assure the proper operation of circuit protective devices as well as assuring operating personnel in the vicinity of the generation facilities are not exposed to the danger of critical electric shock.

3.1.2 Relaying and Controls: IPC electric facilities are subject to a variety of hazards. Among these are lightning, wind, animals, automobiles, malicious mischief, human error, and equipment failures. The electric problems, which can result from these hazards, are principally either faulted or broken circuits. These conditions require that the circuit be de-energized as soon as possible because of the hazards they pose (both safety and equipment damage). IPC installs equipment that is adequate, under expected circumstances, to detect and disconnect faulted equipment or circuits from the IPC system. Since a parallel generator represents another source of power, it alters the load flow and system protection characteristics of a circuit, both during normal and faulted conditions, as well as affecting the operation of automatic reclosing controls.

3.1.3 Power Quality: Power quality issues that must be considered for any interconnected generation are voltage regulation, harmonics, flicker, and phase unbalance because they affect both IPC and its customers. All

generators have an affect on power quality to some degree, and certain measures may be required to mitigate these effects. When multiple generators are connected to the same circuit, they may have a cumulative affect on the power quality and additional measures may be required.

3.1.4 Islanding: Depending on its type and capacity and its relationship to the IPC circuit load at any instant, a Generator may be able to maintain electric supply to other customers on a circuit when that circuit is disconnected from IPC. In this condition, the isolated system may continue to operate independent of IPC causing a safety hazard, and likely with abnormal voltage or frequency causing problems for other IPC customers.

3.1.5 System Control: The loading of large generators is typically controlled by a central computer that continuously monitors the system load from instant to instant and adjusts the generator throttles accordingly (automatic generation control) to match the system load. This type of control system requires continuous and accurate telemetering of generators and utility ties, and requires communications circuits to link the various system generation components to the central computer. Large Generators are required to be incorporated into the automatic generation control scheme as well as smaller Generators in physical locations where there is a large penetration of distributed small generators.

3.1.6 Metering: The complexity and arrangement of the utility metering equipment will depend on the size of the generator and the contractual arrangements for the purchasing of the generation output. Generators that intend to sell the generation output off system will be required to meter their generation output continuously, and telemeter the real-time data to a central location for comparison with an established transmission schedule.

The equipment and requirements described in the following sections are intended to address the concerns and additional responsibilities noted above. These requirements are few for small installations but increase as the size of the generation increases.

3.2. Electrical Specifications

Parallel generation shall meet the following specifications:

3.2.1 Voltage: Matching the rated voltage of the IPC circuit at the point of interconnection; 106 V to 132 V rms phase to ground (nominal 120 V rms base) unless agreed upon otherwise.

3.2.2 Voltage Regulation: In accordance with ANSI C84.1, Range A. Automatic voltage regulation is not allowed unless it is fully integrated with the system operations, and the voltage is adjusted to meet an operational schedule as contracted with IPC.

3.2.3 Frequency: 59.3 Hz to 60.5 Hz.

3.2.4 Limitation on DC injection: No greater than 0.5% of rated output current and in accordance with the latest edition of IEEE 929.

3.2.5 Limitation of Voltage Flicker: In accordance with the latest edition of IEEE 141 and must not exceed the limits defined by the maximum permissible voltage fluctuations border line of visibility curve, Figure 10.3 identified in IEEE 519.

3.2.6 Harmonics: Limit the maximum individual frequency voltage harmonic to 3% of the fundamental frequency, and the voltage Total Harmonic Distortion (THD) to 5% at the point of interconnection in accordance with the latest edition of IEEE 519.

3.2.7 Surge Capability: In accordance with the latest edition of IEEE/ANSI C62.41 or IEEE C37.90.1.

3.2.8 Power Factor: 0.9 power factor (either leading or lagging). Operation outside this range is acceptable provided the power factor is adjusted to meet an operational schedule as contracted with IPC.

3.2.9 Grounding: Generation and interconnection facilities shall be grounded in accordance with the latest edition of ANSI/IEEE 80, National Electrical Safety Code, and National Electrical Code as applicable.

3.3. Generation

3.3.1 Synchronous Generators

Synchronizing facilities: The Generator shall provide automatic synchronizing equipment or manual synchronizing with relay supervision. The synchronizing facilities shall have the following:

1. Slip frequency matching 0.1 Hz, or less.
2. Voltage matching +10%, or less.
3. Phase angle acceptance +10 degrees, or less.
4. Breaker closure time compensation.

Automatic Voltage Regulation (AVR): Each synchronous interconnected unit shall have AVR and such AVR shall be tuned in accordance with IEEE Standard 421 or its successor. Voltage regulator controls and limit functions (such as over/under excitation and volts/hertz limiters) shall coordinate with the Generator's short-term duration capabilities and protective relays. AVRs must be continuously acting and power factor regulation may be required. Unless agreed upon by the Generator and IPC, synchronous generators shall automatically regulate power factor, not voltage, while operating in parallel with IPC's distribution system; however, system stabilization may be required for larger generators connected to the transmission system.

Power System Stabilizer (PSS): Generators greater than 30-MW are required to have a PSS. The PSS shall be installed and operated on generation units with a suitable exciter in accordance with Western Electric

Coordinating Council (WECC) policy statement on PSS and the Reliability Management System (RMS) Criteria.

3.3.2 Induction Generators

Induction generation may be connected and brought up to synchronous speed (as an induction motor) if it can be demonstrated that the initial voltage drop measured at the point of interconnection is acceptable based on current inrush limits. The same requirements also apply to induction generation connected at or near synchronous speed because a voltage dip is present due to inrush magnetizing current. The Generator shall submit the expected number of starts per specific time period and maximum starting kVA data to IPC to verify that the voltage dip due to starting is within the visible flicker limits specified above.

Starting or rapid load fluctuations on induction generators can adversely impact IPC's system voltage. Corrective techniques may be necessary.

The IPC system may provide reactive VAR capacity to the induction generators at the Generator's expense. The installation of power factor correction capacitors by the Generator on the Generator's side of the interconnection point must be reviewed and approved by IPC prior to installation. The installation of capacitance on circuits connected to induction generators increases the possibility of ferroresonance or "self-excitation".

In general, self-excitation can occur with induction machines when the isolated capacitance is about 30 percent of rated kVA, and load that is less than 300 percent of rated kVA. For smaller installations, sufficient capacitance may be present but the load will usually be too large, even for small sections of feeder islands for self-excitation. For large installations, sufficient load may be present but the capacitance will usually be too small unless local power factor correcting capacitors are present. Each installation, especially those where capacitors are installed on the Generator's side of the point of interconnection, will require an evaluation to determine if self-excitation will be a problem and if additional protection equipment is required.

3.3.3 DC Inverters

Direct current generation can only be installed in parallel with IPC's system using a synchronous inverter. The design shall be such that the synchronous inverter disconnects from the system upon an IPC system interruption. Line-commutated inverters do not require synchronizing equipment if the voltage drop is determined to be acceptable. Self-commutated inverters of the utility-interactive type shall be capable of synchronizing to IPC. Stand-alone, self-commutated inverters shall not be used for parallel operation with the IPC.

All inverters shall be "non-islanding" as defined by IEEE 929, and shall meet or exceed the requirements of IEEE 929 and UL 1741. It should be

noted that non-islanding inverters rely on verifying that a perturbation introduced by the inverter is not stabilized by other sources of generation on the system. If an island consists of inverters and other, stable forms of generation like a synchronous generator, the inverter or other specified equipment might not be able to detect that an island exists. Each installation will require an evaluation to determine if other stable forms of generation are connected to the same circuit and whether additional modifications may be required.

3.4 Interconnection Equipment

In general, interconnection equipment includes, but is not limited to, transformation, switching/disconnection, metering, system protection and control, communications/telemetry, and network upgrades.

The interconnection point shall be as described in PART 6 SPECIFIC REQUIREMENTS of this document. All interconnection equipment electrically located on the generator side of the interconnection point shall be owned and maintained by the Generator. All interconnection equipment electrically located on the utility side of the interconnection point shall be owned, operated, and maintained by IPC.

All interconnection equipment shall meet applicable UL, ANSI and IEEE standards, and shall be installed to meet all applicable local, state and federal codes.

3.4.1 Dedicated Transformer

IPC may require a power producing facility to connect to the IPC system through a dedicated transformer.

The transformer may be necessary to ensure conformance with IPC safe work practices, to enhance service restoration operations, to limit available fault current, to prevent detrimental effects (such as voltage fluctuations or harmonics) to other IPC customers, or to ensure that the generator cannot become isolated with a small amount of other customer load. The dedicated transformer that is part of the normal electrical service connection of a Generator's facility may meet this requirement if there are no other customers supplied from it. A dedicated transformer is not required if the installation is designed to protect the IPC system and its customers adequately from potential detrimental net effects caused by the operation of the generator.

The transformer shall either be provided by IPC at the Generator's expense, or be provided by the Generator conforming to ANSI C57, and to these requirements. If the Generator chooses to provide the transformer, the transformer shall be multi-tap, where applicable. If IPC provides the transformer, it shall be a wye-ground/wye-ground type.

The Generator is required to limit ground fault current to less than 20A, as measured on the IPC side of the interconnecting transformer. Impedance grounding or transformer winding connections are used to limit the ground

fault current. The winding connections shall be discussed with IPC prior to purchasing the transformer.

If IPC provides the transformer, a high side circuit-interrupting device will be provided for transformer and distribution or system protection. Fuses may be used for transformers smaller than 20-MVA if the Generator provides and owns the transformer contingent on a coordination check with existing IPC protection. A 3-phase circuit interrupting device, recloser or power circuit breaker, will be used for transformers 20-MVA and larger, dependent on the interconnection location and generator size.

3.4.2. Revenue Metering

Usually when a generator is installed with the intent of selling power to IPC or other entities, electric service to the auxiliary load associated with the generator plant is also needed. As such, power may flow into or out of the plant at different times. Deliveries to and from the plant must be separately recorded and treated as separate entities under IPC's tariffs unless the generation facility qualifies under the Net Metering tariff. Therefore, bi-directional or separate metering will be required. In the case of small tariff-defined Net Metered facilities (25-kVA and smaller), only one kilowatt hour meter will be used to record power flow both into and out of the power producing facility and other loads connected downstream of the meter.

All meters will be owned, operated, and maintained by IPC at the Generator's expense. The Generator will provide, install, own and maintain all mounting structures, conduits, meter sockets, meter socket enclosures, metering transformer cabinets, and switchboard utility service sections of the size and type approved by IPC.

3.4.3. Disconnect Device

Generating equipment shall be capable of being isolated from the IPC system by means of an accessible load-break disconnecting device.

The disconnect device shall be rated for the voltage and current requirements of the installation. The basic insulation level (BIL) of the disconnect device shall be such that it will coordinate with that of IPC's system.

The location of the disconnect device shall be as specified herein or as determined by mutual agreement, and be readily accessible, operable, and lockable (where applicable) by IPC at all times.

A disconnect device located on the low voltage side of the dedicated transformer that is owned and maintained by the Generator shall meet the following:

- Be clearly marked, "Generator Disconnect Device", with permanent 3/8 inch letters or larger.

- Located within 10 feet of IPC's external electric service meter or the location and nature of the distributed power disconnection devices shall be indicated in the immediate proximity of the electric service entrance.

The disconnect device shall either be provided by IPC at the Generator's expense, or be provided by the Generator conforming to these requirements.

3.4.4. Protection and Control Equipment

With the exception of non-islanding inverters (meeting IEEE 929 and UL 1741), appropriate protection and control equipment, including a circuit interrupting device (e.g. circuit breaker), shall be required to disconnect the generation from the IPC system. The protection and control equipment shall be capable of disconnecting the generation upon detection of an islanding condition, IPC system fault, Generator system fault, and other abnormal conditions on the circuit in which the generation is connected.

The protection and control scheme shall be designed to allow the generation to operate only within the limits specified herein or as required by the WSCC for frequency and voltage. As a minimum, a circuit interrupting device(s) operated by over and under voltage protection on each phase is required. The circuit interrupting device(s) shall also be operated by over and under frequency protection on at least one phase. All phases of a generator or inverter interface shall disconnect for a voltage or frequency excursion on any phase.

The need for additional protection and control equipment shall be determined by IPC on a case-by-case basis. The specific design of the protection and control will depend on the size and characteristics of the generation, the Generator's load level, transformer connections, and the characteristics of the particular portion of IPC's system where the Generator is interconnecting. IPC shall specify and provide settings for those relays that IPC designates as being required to satisfy protection practices. Any protective equipment or setting specified by IPC shall not be changed or modified at any time by the Generator without written consent from IPC.

Utilities, including IPC, often use high speed (30 cycle or less) reclosing of their substation circuit breakers to rapidly restore service to customers after temporary line faults (automatic load restoration). This could cause problems to a Generator if they are reconnected out-of-phase with the system voltage. To avoid out-of-phase reclosing, the design of the protection and control scheme shall take into account the IPC practice of automatically reclosing circuit breakers without synchronism check as quickly as 12 cycles after being tripped.

The Generator's protection equipment shall not share electrical equipment and instrument transformers associated with IPC revenue metering.

A failure of the interconnection protection equipment, including loss of control power, shall open the circuit interrupting device, thus disconnecting the generation from the IPC system. The protection equipment shall utilize a non-volatile memory design such that a loss of internal or external control power, including batteries, will not cause a loss of interconnection protection functions or loss of protection set points.

Protective relay requirements:

1. Meet IEEE/ANSI C37.90.
2. Maximum pickup accuracy of 3% for overcurrent elements.
3. Maximum pickup accuracy of 5% for under- and overvoltage elements.
4. Maximum timer accuracy of 3%.
5. Maximum pickup accuracy of 0.05 Hz for frequency elements.

A dedicated DC power supply (battery or UPS) is required for all generation projects larger than 300-kW.

The protection and control equipment will be either provided by IPC at the Generator's expense, or be provided by the Generator conforming to IPC's specifications depending upon the size of the generation as specified herein and the system voltage at the point of interconnection.

3.4.5. Telemetry

Depending upon the generator size and the contractual arrangements for the generation output, the Generator may be required to maintain satisfactory operating communications with IPC to transmit metering data from the point of interconnection for IPC's system control and metering database. The Generator will obtain and pay any associated monthly charges to the provider for a full duplex data circuit (or circuits) operating at a minimum of 28800 baud, or at other baud rates as reasonably specified by IPC.

Depending upon the generator size, a Remote Terminal Unit ("RTU"), or equivalent data collection and transfer equipment acceptable to both the Generator and IPC, and communication to IPC may be required for IPC system operations. The RTU will be used to gather accumulated and instantaneous data, breaker position, transfer trip control, etc, to be telemetered to a location, or locations, designated by IPC. Generator will obtain, and pay any associated monthly charges to the provider, a full duplex data circuit (in addition to that required for system control and metering discussed above) operating at a minimum of 28800 baud, or at other baud rates as reasonably specified by IPC.

The Generator will be required to provide standard voice and facsimile communications at its generation facilities through use of the public telephone system. It is the Generator's responsibility to contact the local

telephone company to arrange and pay for a separate phone line for data communications, and ongoing phone service.

3.4.6. Network Upgrades

When Generators are connected to circuits that utilize high speed reclosing of the substation circuit breakers to restore service after temporary line faults, modifications to the circuit control schemes are considered. One solution is for IPC to disconnect their reclosing devices on lines serving a Generator; however, this results in a deterioration of service for other customers. A second alternative is to continue high speed reclosing and assume that the Generator relaying will cause disconnection before reclosing can occur; however, this could result in some equipment damage if a Generator relaying misoperation occurs. A third alternative is to have IPC send a transfer trip signal to the Generator before reclosing occurs; however, this is quite expensive. Another, more practical, alternative is for IPC to block reclosing until the Generator is disconnected and voltage-supervising relays indicate the line is dead. Any of the required equipment and modifications associated with the above-noted alternatives is considered network upgrades.

Other examples of network upgrades may include, but are not limited to such items as line extensions, disconnect switches required for equipment isolation to perform routine maintenance, additional line terminal relaying or modifications, additional circuit interrupting devices, power factor correction capacitor banks, additional communications equipment or modifications, etc. The requirements for network upgrades vary and will be determined based on the physical and electrical location of the generator interconnection within the IPC system.

PART 4 OPERATING REQUIREMENTS

4.1. General

The Generator shall provide a 24-hour telephone contact(s) to IPC. This contact will be used by IPC to arrange access for repairs, inspection or emergencies. IPC will make such arrangements (except for emergencies) during normal business hours.

IPC will provide a name and telephone number so that the Generator can obtain information about any IPC activity impacting the Generator's generation (outages, disconnection, etc.).

The Generator shall never supply power to IPC during an outage on the system serving the Generator. The Generator's generation may be operated during such outages only with an open tie to the IPC system.

The disconnect device may be opened by IPC at any time for any of the following reasons:

- To eliminate conditions that constitute a potential hazard to IPC personnel or the general public;

- Pre-emergency or emergency conditions on the IPC system;
- A hazardous condition is revealed by a IPC inspection;
- Protective device tampering.

The disconnect device may be opened by IPC for the following reasons, after notice to the responsible party has been delivered and a reasonable time to correct (consistent with the conditions) has elapsed:

- A Generator has failed to make available records of maintenance tests and maintenance of its protective devices;
- A Generator's system interferes with IPC equipment or equipment belonging to other IPC customers;
- A Generator's system is found to affect quality of service of adjoining customers.

IPC will disconnect the Generator in the event of any planned or unplanned maintenance or repair of the system connected to the Generator. In the event of unplanned maintenance or repairs, no prior notice will be provided. In the event of planned repairs, IPC will attempt to notify the Generator of the time and duration of the planned outage.

To the extent required by applicable rules and regulations, Generator shall (a) request permission from IPC prior to opening or closing circuit breakers that affect IPC's system, (b) carry out switching orders from IPC in a timely manner and (c) keep IPC advised of the Generator's operational capabilities as required for reliable operation of IPC's system.

IPC may require direct transfer trip (remote operation of a circuit breaker by means of a communications channel) whenever:

- The minimum load to generation ratio on a circuit is such that a ferroresonance condition could occur,
- It is determined that the Generator's protective relaying may not operate for certain conditions or faults and/or,
- The installation could increase the length of outages on a circuit or jeopardize the reliability of the circuit.

IPC will be required to demonstrate the need for direct transfer trip.

More detailed operating requirements are provided in the Generator Interconnection Agreement or applicable IPC tariff.

PART 5 TEST REQUIREMENTS

5.1. General

When the Generator owns, operates, and maintains the interconnection protection and control equipment, either as discrete components specified herein or as part of a DC inverter package, the Generator shall conform to these test requirements.

This section is divided into "acceptance testing" and "maintenance testing". Acceptance testing is performed on the interconnection equipment prior to the first parallel operation to verify that it meets the performance requirements specified. Maintenance testing is site-specific, periodic testing to assure continued acceptable performance of the interconnection protection equipment.

These test requirements apply only to interconnection disconnection devices and the protection and control equipment (e.g. those equipment protecting IPC personnel, the IPC system, and IPC's customers). Testing of equipment associated specifically with protection or control of Generator's equipment is recommended, but not required unless they impact the interconnection protection.

The Generator, at his option, may either request IPC to perform, or have a qualified testing firm perform, the required acceptance and maintenance tests. If a qualified testing firm performs the required tests, the test results shall be submitted to IPC. In any case, IPC staff will evaluate the test results and provide approval for interconnection or continued operation if the results are satisfactory.

If the Generator elects to retain a qualified testing firm, the testing firm shall have the following minimum qualifications:

A. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.

B. Technicians certified by NICET (National Institute of Certification in Engineering Technologies) or NETA (InterNational Electrical Testing Association).

C. Corporately and financially independent organization functioning as an unbiased testing authority.

D. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.

Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS (Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems). Test instrument calibration and documentation shall be in accordance with NETA ATS.

The testing firm shall perform inspection and testing in accordance with NETA ATS and NETA MTS (Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems) and as required herein.

IPC reserves the right to witness any testing.

5.2. Acceptance Testing

An acceptance test must be performed to verify that the equipment meets the requirements specified herein prior to initial parallel operation by a Generator, or any time interface hardware or software is changed.

Prior to testing, all batteries shall be disconnected or removed for a minimum of ten (10) minutes. This test is to verify the system has a non-volatile memory and that protection settings are not lost. A test shall also be performed to determine

that failure of any battery not used to supply trip power will result in an automatic shutdown.

All DC inverters shall be tested in accordance with the latest edition of IEEE 929 and UL 1741.

These tests shall also verify the Generator will not automatically reconnect to the utility system until after five (5) minutes of continuous normal voltage and frequency on the utility system. The DC inverter manufacturer may supply a special production sample with the five minute reset timer disabled to eliminate waiting time during acceptance testing. At least one test must be performed on a sample with a five minute reset timer to verify the function and accuracy of the timer.

5.3. Maintenance Testing

A maintenance test is required to determine if the equipment meets the requirements specified herein; to verify the interconnection protection and control has not been tampered with; and to verify the interconnection equipment meets safety codes and standards. In addition, all maintenance tests prescribed by the manufacturer shall be performed.

Maintenance testing shall be performed annually, or as negotiated otherwise.

Any system that depends upon a battery for trip power shall be checked by the Generator and logged once per month for proper voltage. Once every four (4) years the battery must be either replaced or a discharge test performed.

PART 6 SPECIFIC REQUIREMENTS

6.1. Generation Classifications

IPC has established three different classes for non-utility parallel generation, each with distinctive requirements. These classes are as follows:

A. Less than 100-kVA.

B. 100-kVA to 1-MVA.

C. More than 1-MVA.

Where multiple generators are connected to IPC's system through a single service point, the class will be determined by the sum of the ratings of the generators. Multiple generators may be allowed to connect through an equal number of service points in order to stay within a defined generation classification; however, *the Generator must submit separate generator interconnection applications for each generation installation.*

It should be understood that these classes have been established for convenience and are based on normal load density and an assumed low density of parallel generation on the serving circuit. The final decision as to the requirements for each installation will be made depending on generation output, system voltage and capacity at the Generator location, Generator load magnitude, the magnitude of other load connected to that circuit/system, available short circuit contribution, etc.

As a general rule, generation that is less than 10-MVA is usually connected to the distribution system (34.5-kV or less) or the sub-transmission system (69-kV or less); generation from 10-MVA to 100-MVA is usually connected to the transmission system (138-kV and less); and generation in excess of 100-MVA is connected to the transmission system (500-kV and less).

6.2. Total Generation Less Than 100-kVA

With the exception of the revenue metering equipment, the Generator, at his option, may provide the interconnection equipment.

In small single-phase applications, generation facilities applied on a center-tap neutral 240-volt, single-phase service must be installed such that no more than 6-kVA of imbalance in capacity exists between the two sides of the 240-volt service. For dedicated transformer services, the limit of a single-phase generator shall be the transformer nameplate rating.

Interconnection Point: If IPC owns the dedicated transformer, the interconnection point shall be the generator side of the utility revenue meter. If the Generator owns the dedicated transformer, the interconnection point shall be the generator side of the primary voltage disconnect device.

Dedicated transformer: In general, Generators less than 100-kW generating at a secondary voltage level may not require a dedicated transformer. However, this must be approved by IPC after review of the project details, and it is determined that the facilities will adequately protect the IPC system and its customers from potential detrimental effects caused by the operation of the generator.

Revenue Metering: Metering facilities will be determined by the requirements of the individual installation, contractual arrangements, and applicable tariff.

Disconnect device: The electrical location of the disconnect device depends upon the ownership of the dedicated transformer.

If the Generator owns the dedicated transformer, the disconnect device will be installed, owned, operated, and maintained by IPC, and located on the utility side of the transformer.

If IPC owns the dedicated transformer, the disconnect device may be installed, owned, and maintained by the Generator, and installed on the Generator side of the dedicated transformer. If the disconnect device is installed on the Generator side of the dedicated transformer, the disconnect device shall be physically located at or near the point of interconnection (metering location). In tariff defined Net Metering applications, the disconnect device shall be electrically located between the generation equipment and the facility load.

The disconnect device is to enable IPC to disconnect the generation from the IPC system for safety while working on the lines, or to disconnect generation that does not meet the requirements specified herein or other contractual arrangements.

Protection and Control equipment: The Generator may own, operate and maintain the interconnection protection and control equipment. The provisions discussed in PART 5 TEST REQUIREMENTS of this document apply.

With the exception of non-islanding inverters (meeting IEEE 929 and UL 1741), the interconnection package shall be equipped with a circuit-interrupting device (line voltage relay or contactor) with associated voltage and frequency relaying that will prevent the generator from being connected to a de-energized or single-phased (if normally three-phase) source. If it is possible an island can develop with non-islanding inverters and other stable forms of generation (like a synchronous generator) on the same circuit, a non-islanding inverter will require a circuit interrupting device with associated voltage and frequency relaying.

The circuit-interrupting device shall automatically disconnect from the IPC system as follows:

- Within ten (10) cycles if the voltage falls below 60-V rms phase to ground (nominal 120-V rms base) on any phase.
- Within two (2) seconds if the voltage falls below 106 V rms phase to ground (nominal 120 V rms base) on any phase.
- Within one (1) second if the voltage rises above 132 V rms phase to ground (nominal 120 V rms base) on any phase.
- Within ten (10) cycles if the voltage rises above 144 V rms phase to ground (nominal 120 V rms base) on any phase.
- Within ten (10) cycles if the frequency rises above 60.5 Hz or falls below 59.3 Hz.

Following a generation facility disconnect as a result of a voltage or frequency excursion, the generation facility shall remain disconnected until IPC's service voltage and frequency are within the operating voltage range of 106V-132V, and frequency range of 59.3 Hz –60.5 Hz for a minimum of five (5) minutes.

The controls (typically consisting of control switches, lockout relays and other discrete components) shall perform the following control functions:

- The Generator can allow the circuit-interrupting device to close or force it to trip. However, the Generator cannot force the circuit-interrupting device to close or prevent it from tripping.
- If the circuit-interrupting device closes into a fault it will trip and lockout requiring a manual reset.

IPC will maintain a list of protective relays that have been acceptance tested and approved for interconnection to the IPC system. The list will indicate specific model numbers and firmware versions approved. The installed equipment must have a nameplate that clearly shows the model number and firmware version (if applicable).

Network Upgrades: Network upgrades shall be as required on a case-by-case basis.

6.3. Total Generation 100-kVA to 1-MVA

With the exception of the revenue metering equipment and the protective relaying and control equipment, the Generator, at his option, may provide the interconnection equipment (including the interconnection circuit interrupting device).

Interconnection Point: If IPC owns the dedicated transformer, the interconnection point shall be the generator side of the utility revenue meter. If the Generator owns the dedicated transformer, the interconnection point shall be the generator side of the primary voltage disconnect device.

Dedicated transformer: In general, the Generator shall be served through a dedicated transformer that serves no other customers.

Revenue Metering: Metering facilities will be determined by the requirements of the individual installation and contractual arrangements.

Disconnect device: The electrical location of the disconnect device depends upon the ownership of the dedicated transformer.

If the Generator owns the dedicated transformer, the disconnect device will be installed, owned, operated, and maintained by IPC, and located on the utility side of the transformer.

If IPC owns the dedicated transformer, the disconnect device may be installed, owned, and maintained by the Generator, and installed on the Generator side of the dedicated transformer. If the disconnect device is installed on the Generator side of the dedicated transformer, the disconnect device shall be physically located at or near the point of interconnection (metering location).

The disconnect device is to enable IPC to disconnect the generation from the IPC system for safety while working on the lines, or to disconnect generation that does not meet the requirements specified herein or other contractual arrangements.

Protection and Control Equipment: The Generator, at his option, may provide the circuit-interrupting device on the secondary side of the transformer. The circuit-interrupting device (circuit breaker or contactor) shall have remote "trip" capability and also meet the requirements of the National Electrical Code.

IPC will provide the protective relaying instrument transformers (current transformers and potential transformers), protective relaying, dedicated DC power supply, and associated controls to remotely operate the circuit-interrupting device. Additional constraints may be required for the circuit-interrupting device based on other system characteristics.

Telemetry: Depending upon the generator size and the contractual arrangements for the generation output, the Generator may be required to maintain satisfactory operating communications with IPC to transmit metering data from the point of interconnection for IPC's system control and metering database. In addition, an RTU may be required for transfer trip, etc.

If telemetry is required, the Generator will obtain (and pay any associated monthly charges to the provider), a full duplex data circuit, or circuits operating at a minimum of 28800 baud or at other baud rates as reasonably specified by IPC.

Network upgrades: Network upgrades shall be as required on a case-by-case basis.

6.4. Total Generation More Than 1-MVA

With the exception of the revenue metering equipment, protection and control equipment, and disconnect device the Generator, at his option, may provide the interconnection equipment.

Interconnection Point: Regardless of dedicated transformer ownership, the interconnection point shall be the generator side of the disconnect device.

Dedicated transformer: The Generator shall be served through a dedicated transformer that serves no other customers.

Revenue Metering: Metering facilities will be determined by the requirements of the individual installation and contractual arrangements.

Disconnect device: IPC will own, operate, and maintain the disconnect device. The electrical location of the disconnect device depends upon the ownership of the dedicated transformer.

Protection and control equipment: IPC will own, operate, and maintain all circuit interrupting devices, protective relaying and controls, instrument transformers, and associated AC and DC power supply. Multifunction protective relays and redundant relaying (where applicable) are required. Synchronizing to the system using IPC's circuit interrupting devices may be allowed provided certain operating constraints are met.

Telemetry:

Communications: Data circuit(s) shall extend from the Generator's facility to a location, or locations, specified by IPC. Operational communications shall be activated and maintained under, but not be limited to, the following events: system paralleling or separation, scheduled and unscheduled shutdowns, equipment clearances, and hourly and daily load data exchange.

Remote Terminal Unit: Generator shall install or facilitate installation of RTU equipment, and the installation shall be accomplished prior to the first parallel operation. IPC will specify the communication protocol for the data circuits. Instantaneous bi-directional analog real power and reactive power flow information, circuit breaker status information, instantaneous analog voltage information, metering information, and disturbance monitoring information, as determined by IPC, must be telemetered directly to the location, or locations, specified by IPC.

The Generator may also be required to provide standard voice and facsimile communications at its generation facilities through use of the public telephone system.

Network Upgrades: If IPC owns the dedicated transformer, protection equipment and relaying may be required on the transformer secondary circuit. That equipment as well as the need for additional elements (substation equipment,

control facilities, disconnect devices, etc.) will be determined, on a case-by-case basis.

System Operation:

Obligation to Supply or Absorb Reactive Power: The Generator shall supply reactive power to, and absorb reactive power from, the Transmission Owner's System during periods of time that its facility is connected to and operating in parallel. The Generator shall respond to requests from the Transmission Owner to increase or decrease the facility's reactive power output in a manner consistent with the Generator's obligation to operate the facility (a) in a safe and reliable manner in accordance with applicable operational and/or reliability criteria, protocols, and directives (which include those of NERC and WSCC) and (b) in accordance with the provisions of the interconnection agreement. The facility shall generate such reactive power in accordance with the voltage schedule, reactive schedule or power factor schedule, whichever is applicable, that is prescribed by the Transmission Owner, but not in excess of the amount available from the facility's equipment in operation at the time. Such limitation shall be in accordance with results of the System Impact Study and the Facilities Study conducted by the Transmission Owner on behalf of the Generator.

Reactive Power Standards: The Generator shall operate the facility to maintain a voltage schedule, reactive schedule or power factor schedule; whichever is applicable, as prescribed by the System Operator within the facility's reactive design limitations. The System Operator may request the Generator to change its voltage schedule, reactive schedule or power factor schedule, whichever is applicable, or request the Generator to supply its maximum available reactive power output or absorb its maximum reactive power input (measured in MVAR) within the reactive design limitations of the equipment in operation at the time in order to maintain system security. In the event the facility is unable to consistently maintain a reactive power capability sufficient to maintain a power factor at the interconnection point within the facility's reactive design limitations, the Generator shall take other appropriate steps to configure the facility to meet such standards, including, as necessary, the installation of dynamic reactive power compensating devices subject to prior review and approval by the Transmission Owner.

System Security**:** In order to maintain security on the Transmission Owner's System, during an Emergency on the Transmission Owner's System or on a transmission system connected to Transmission Owner's System, the System Operator has the authority to direct the Generator to increase or decrease real power production (measured in MW) and/or reactive power production (measured in MVAR), within the design and operational limitations of the facility equipment in operation at the time,.

PART 7 REFERENCES

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

ANSI/IEEE Standard 519-1992, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems.

ANSI/IEEE Standard 929-2000, IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems.

ANSI/IEEE Standard 1001-1988, IEEE Guide for Interfacing Dispersed Storage and Generation Facilities with Electric Utility Systems.

ANSI/IEEE Standard C37-1995, Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses.

ANSI/IEEE Standard C37.2-1996, IEEE Standard Electrical Power System Device Function Numbers and Contact Designations.

ANSI/IEEE Standard C37.90-1989, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.

ANSI/IEEE Standard C57-1995, Distribution, Power, and Regulating Transformers.

ANSI/IEEE 80 – 1986, IEEE Guide for Safety in AC Substation Grounding.

ANSI/NFPA 70–1999, National Electrical Code.

IEEE 141-1993, Recommended Practice for Electric Power Distribution for Industrial Plants – Red Book.

IEEE P1547/D07-2001, Draft Standard for Interconnecting Distributed Resources with Electric Power Systems.

IEEE/ANSI C2-1997, National Electrical Safety Code.

IEEE/ANSI C62–1995, Surge Protection.

NEMA MG 1-1993, Motors and Generators.

UL 1741 May 1999, Standard for Static Inverters and Charge Controllers for use in Photovoltaic Power Systems.