Revision 3
Submitted 11/30/99

# Arizona State

# Draft

# Interconnection Requirements

# For

# Distributed Generation

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# 1. FORWARD

This revised document entitled "Arizona State Draft Interconnection Requirements for Distributed Generation" ( Revision 3), is presented to the Arizona Corporation Commission by the Interconnect Standards Committee with the intent of recommending interconnection standards to the Commission for eventual adoption and implementation within the State of Arizona. It replaces the Draft Revision 2 previously submitted on 11/22/99.

The methodology initially agreed to and employed by the committee was to begin with a strawman document, based on existing Arizona utility standards. It served as a basis for discussion and subsequent modification in order to develop this document, once consensus by the committee members on the various issues had been achieved. Interconnection documents from other states were also reviewed.

Committee members initially agreed that a user-friendly document would be desirable. Hence, an attempt has been made to incorporate descriptive and explanatory language throughout the document.

With this revision broad consensus has been achieved on all sections. In an effort to present a document which was representative of the various view points expressed, and where consensus was not achieved on specific items in the sections, additional notes have been included outlining major differing views by inserting as comments **(IN BOLD CAPITALS)** within the sections.

Section 9, Metering Requirements, previously determined to fall into the scope of work of the Metering, Access, and Dispatch Committee, has now been removed from the document.

Members of the interconnect standards committee appreciate being afforded the opportunity by commission staff to further refine and complete this document. It is generally felt that by bringing this document to a satisfactory conclusion, in as much as consensus can be achieved, will be beneficial to the distributed generation industry and utilities as a whole in the state.

# 2. SCOPE

This document specifies the Arizona utility (UDC) requirements for safe and effective interconnection of distributed generation with a utility radial distribution system. **(THE COMMITTEE HAS NOT REACHED A CONSENSUS ON ALLOWING DISTRIBUTED GENERATORS ON NON-RADIAL SYSTEMS.)** Interconnection requirements as outlined here are for those installations that will be connected to the utility electric power distribution system and do not backfeed onto the utility transmission system. Installations that interconnect to, or backfeed onto, the transmission system may have additional utility requirements and will also need to comply with all applicable WSCC (Western Systems Coordinating Council), AZ-ISA (Arizona Independent Scheduling Administrator), Desert STAR Independent System Operator, NERC (North American Electric Reliability Council) and RTO (Regional Transmission Operator) requirements as applicable. Facilities that will be connected directly to the transmission system will be reviewed by the utility on an individual basis.

For the purpose of simplicity, the term "Customer" will be used here to refer to a utility customer who installs, owns or operates a distributed generator, cogenerator or small power producer, even though the Customer may not actually be a purchaser of power from the utility, and includes any independent party or entity that either invests in, owns or operates a distributed generator or generation facility.

The required protective relaying and/or safety devices and requirements specified in this document are for protecting only utility facilities and other utility customers' equipment from damage or disruptions caused by a fault, malfunction or improper operation of the distributed generating facility. They are also necessary to ensure the safety of utility workers and the public. The requirements specified herein do not include additional relaying, protective or safety devices as may be required by industry and/or government codes and standards, equipment manufacturer requirements and prudent engineering design and practice to fully protect Customer’s generating facility or facilities; those are the sole responsibility of the Customer. In addition to all applicable regulatory, technical, safety, and electrical requirements and codes, Customers will also be subject to contractual and other legal requirements, which will govern over the general provisions in this document.

Customers and utility personnel shall use this document when planning the installation of distributed generation. Note that these requirements may not cover all details in specific cases. The Customer should discuss project plans with the utility before designing the facility or purchasing and installing equipment. This document must be applied in conjunction with applicable utility rate tariffs and electrical service schedules and requirements that pertain to the operation of distributed generation with the utility electrical distribution system.

# 3. DEFINITIONS

3.1 Clearance Point: A clearance point is the physical location on a piece of line or equipment that is to be de-energized from all known sources of power. It is at this physical piece of line or equipment that tags will be installed.

3.2 Cogeneration Facility: Any facility that sequentially produces electricity, steam or forms of useful energy (e.g., heat) from the same fuel source and which are used for industrial, commercial, heating, or cooling purposes.

3.3 Customer: Any utility customer who installs, owns or operates a GF, even though the customer may not actually be a purchaser of power from the utility, and includes any independent party that either invests in, owns or operates a distributed generator or generating facility.

3.4 Distributed Generator: Any type of electrical generator or static inverter producing alternating current that (a) has the capability of parallel operation with the utility distribution system, or (b) is designed to operate separately from the utility system and can feed a load that can also be fed by the utility electrical system. A distributed generator is sometimes referred to simply as "generator".

3.5 Electric Supply/Purchase Agreement: An agreement, together with appendices, signed between the utility and the Customer (Generating Facility) covering the terms and conditions under which electrical power is supplied and/or purchased to/from the utility.

3.6 ESP (Electric Service Provider): A company supplying, marketing or brokering at retail any competitive services pursuant to a Certificate of Convenience and Necessity.

3.7 Generating Facility (GF): All or part of the Customer's distributed electrical generator(s) or inverter(s) together with all protective, safety, and associated equipment necessary to produce electric power at the Customer's facility. A GF also includes any Qualifying Facility (QF).

3.8 Hold Tag (also called Contact Tag): The method used as an aid in protection of personnel working on or near energized equipment, whereby automatic or remote re-closing of a line is disabled. When a hold (or contact) tag is in effect, if the circuit trips open, it will not be re-closed until it is verified that all personnel are in the clear. As it relates to distributed generation, circuits with hold tags shall have all potential sources of backfeed removed by opening, locking and tagging the appropriate disconnect switch.

3.9 Interconnect Agreement: An agreement, together with appendices, signed between the utility and the Customer (Generating Facility) covering the terms and conditions governing the interconnection and operation of the Generating Facility with the utility.

3.10 Islanding: A condition occurring when a generator and a portion of the utility system separate from the remainder of the utility system and continue to operate in a energized state (copyright EPRI).

3.11 Metering Service: All functions related to measuring electricity consumption.

3.12 MSP (Meter Service Provider): An entity providing Metering Service, as that term is defined herein.

3.13 Parallel Operation: The operation of a GF that is electrically interconnected to a bus common with the utility electrical system, either on a momentary or continuous basis.

3.14 Points of Interconnection: The physical location where the utility's service conductors are connected to the Customer's service conductors, at which point the power transfer occurs between the Customer's electrical system and the utility distribution system, also commonly referred to as the Point of Common Coupling.

3.15 Qualifying Facility (QF): Any Cogeneration or Small Power Production Facility that meets the criteria for size, fuel use, efficiency, and ownership as promulgated in 18 CFR, Chapter I, Part 292, Subpart B of the Federal Energy Regulatory Commission's Regulations.

3.16 Relay: An electric device that is designed to interpret input conditions in a prescribed manner and after specified conditions are met to respond to cause contact operation or similar abrupt change in associated electric control circuits.

3.17 Small Power Production Facility: A facility that uses primarily biomass, waste or renewable resources, including wind, solar, and water to produce electric power.

3.18 Utility: The electric utility entity that constructs, operates and maintains the electrical distribution system for the receipt and/or delivery of power, also referred to as the Utility Distribution Company (UDC).

3.19 Utility Grade Relays: Relays specifically designed to protect and control electric power apparatus, tested in accordance with the following ANSI/IEEE standards:

(a) ANSI/IEEE C37.90-1989 (R1994), IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
(b) ANSI/IEEE C37.9.01-1989 (R1994), IEEE Standard Surge Withstand (SWC) Tests for Protective Relays and Relay Systems.
(c) ANSI/IEEE C37.90.2-1995, IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.

# 4. OVERVIEW OF DISTRIBUTED GENERATION ISSUES

Any Customer qualified under the Public Utility Regulatory Policies Act (PURPA) of 1978, may operate his generating equipment in parallel with the utility provided the Customer provides equipment that will:

(a) not present any hazards to the utility personnel, other customers or the public,
(b) minimize the possibility of damage to the utility or other customer equipment,
(c) not adversely affect the quality of service to other customers, and
(d) minimally hamper efforts to restore a feeder to service (specifically when a clearance or hold tag is required).

In addition, the Customer will also need to comply with the following:

(a) the generating facility meets all the interconnection, safety, and protection requirements outlined in this document,
(b) Customer signs an Interconnect Agreement, as well as an Electric Supply /Purchase Agreement, as applicable, with the utility, and
(c) Customer complies with and is subject to all applicable service and rate schedules and requirements, rate tariffs and other applicable requirements as filed with and approved by the Arizona Corporation Commission for regulated utilities.

Customer generating equipment that does not qualify under PURPA may also be operated in parallel with the utility provided that all of the conditions outlined above are complied with.

**(IT IS GENERALLY EXPECTED BY COMMITTEE MEMBERS THAT A POLICY DECISION SHOULD BE MADE BY THE ACC REGARDING THE INTERCONNECTION OF GENERATORS NOT QUALIFIED UNDER PURPA.)**

Due to relay coordination and potential backfeed and stability problems, a utility may not permit any distributed generation to be connected to a network system.

**(THE COMMITTEE HAS NOT REACHED CONSENSUS ON ALLOWING DISTRIBUTED GENERATORS ON NETWORKED SYSTEMS. AT LEAST ONE OTHER STATE'S INTERCONNECTION REQUIREMENTS PROPOSED TO ALLOW CONNECTION TO NETWORK SYSTEMS, WITH CERTAIN LIMITATIONS. IT IS NOT CLEAR AS TO THE TYPE OF NETWORKS ADDRESSED HOWEVER. THE PROSPECT OF INTERCONNECTING WITH NETWORKED DISTRIBUTION SYSTEMS IS A POINT OF CONCERN WITH UTILITY ENGINEERS, FIELD SUPERVISORS AND OPERATORS. UTILITY COMMITTEE MEMBERS AND OPERATIONAL STAFF HAVE STRESSED THAT WITH THE EXISTING CONFIGURATION AND RELAYING, NETWORKS ARE NOT DESIGNED TO OPERATE IN CONJUNCTION WITH CUSTOMER GENERATION. SAFETY, LOSS OF RELIABILITY, IMPOSSIBILITY OF COORDINATING PROTECTIVE RELAYING, LIABILITY, OPERATIONAL CONSTRAINTS, AND COST OF RETROFITS WERE CITED AS BARRIERS. SOME NON-UTILITY MEMBERS FELT THAT RELAY AND PROTECTION REQUIREMENTS COULD TAKE INTO CONSIDERATION GENERATOR SIZE RELATIVE TO SERVICE SIZE AND ALSO GENERATION TYPE. IT WAS SUGGESTED THAT THE**

**ACC CONSIDER SPONSORING A WORKSHOP ON INTERCONNECTION OF DG TO NETWORK SYSTEMS AND SHOULD INVITE ADDITIONAL NETWORK EXPERTS TO DISCUSS THE ISSUES.**

**IT WAS ALSO SPECULATED THAT DISTRIBUTION SYSTEM (EVEN RADIAL) INSTALLATIONS AND UPGRADES IN THE FUTURE MIGHT NEED TO BE DESIGNED OR RE-DESIGNED FOR MULTIPLE-SOURCES AND BI-DIRECTIONAL OPERATION, REFLECTING TRANSACTIONS NOW OCCURRING ON THE LEVEL OF TRANSMISSION SYSTEMS AND EVOLVING TO FUNCTION MORE LIKE THOSE SYSTEMS. IT IS UNCLEAR, HOWEVER, WHO WOULD PAY FOR THIS OR HOW IT WOULD BE IMPLEMENTED).**

The protective and safety devices (relays, circuit breakers, disconnect switches, etc.) specified in this document must be installed and placed into service before allowing parallel operation of Customer's generation facilities with the utility system. The purpose of these devices is to isolate the Customer's generating equipment from the utility system whenever faults or disturbances occur and for maintenance purposes. Modifications to the utility electrical system configuration or protective equipment may also be required, generally at the expense of the Customer, in order to accommodate parallel generation. Additional agreements may be required between the Customer and the utility before modifications to the distribution system are made.

The utility will not assume any responsibility for the protection of the Customer's generator(s), or of any other portion of the Customer's electrical equipment. The Customer is fully and solely responsible for protecting his equipment in a manner to prevent any faults or other disturbances on the utility distribution system from damaging the Customer's equipment.

The Customer must obtain all required permits and inspections indicating that the Customer's generating facility complies with local and other applicable safety codes. The utility can disallow the interconnection of a Customer's generating facility if, upon review of the Customer's design or facility, it determines that the proposed design or facility is not in compliance with applicable safety codes, or is such that it could constitute a potentially unsafe or hazardous condition.

# 5. DISTRIBUTED GENERATION TYPES

Distributed generation is any type of electrical generator or static inverter producing alternating current that (a) has the capability of parallel operation with the utility distribution system, or (b) is designed to operate separately from the utility system and can feed a load that can also be fed by the utility electrical system. A distributed generator is sometimes referred to simply as "generator".

Distributed generators include induction and synchronous electrical generators as well as any type of electrical inverter capable of producing A/C power. A **Separate System, or Emergency or Standby Generation System,** is designed so as to never electrically interconnect or operate in electrical parallel with the utility system. A **Parallel System, or Interconnected Generation System,** is any generator or generation system that can parallel, or has the potential to be paralleled via design or normal operator control, either momentarily or on a continuous basis, with the utility system.

The Customer may elect to run his generator as a separate system with non-parallel load transfer between the two independent power systems, or he may run it in parallel with the utility system. A description and the basic requirements for these two methods of operation are outlined below.

## 5.1 Separate System

A separate system is one in which there is no possibility of electrically connecting or operating the Customer's generation in parallel with the utility's system. The Customer's equipment must transfer load between the two power systems in an open transition or non-parallel mode. If the Customer claims a separate system, the utility may require verification that the transfer scheme meets the non-parallel requirements.

Emergency or Standby generators, used to supply part or all of the Customer's load during a utility power outage, are required by the National Electrical Code (NEC) to have transfer equipment designed and installed to prevent the inadvertent interconnection of normal and emergency sources of supply in any operation of the transfer equipment.

As such, these generators must be connected to the Customer's wiring through a double throw, "break-before-make" transfer switch specifically designed and installed for that purpose. The transfer switch must be of a fail-safe mechanical throw over design, which will under no circumstances allow the generator to electrically interconnect or parallel with the utility system. The transfer switch must always disconnect the Customer's load from the utility power system prior to connecting it to the generator. Conversely, the transfer switch must also disconnect the load from the generator prior to re-connecting it back to the utility system. These requirements apply to both actual emergency operations as well as to testing the generator. All transfer switches and transfer schemes must be inspected and approved by the jurisdictional electrical inspection agency.

Portable generators are not designed to be connected to a building's permanent wiring system, and are not to be connected to any such wiring unless a permanent and approved transfer switch is used. Failure to use a transfer switch can result in backfeed into the utility system – the generator voltage can backfeed through the utility transformer and be stepped up to a very high voltage.

This can pose a potentially fatal shock hazard to anyone working on the power lines or on utility equipment.

Other than the requirements outlined above in this section, the utility has no further technical interconnection requirements for a separate system.

## 5.2 Parallel System

A parallel, or interconnected, generator is connected to a bus common with the utility's system, and a transfer of power between the two systems is a direct result. A consequence of such interconnected operation is that the Customer's generator becomes an integral part of the utility system that must be considered in the electrical protection and operation of the utility system.

Parallel generators encompass any type of distributed generator or generating facility that can electrically parallel with, or potentially backfeed the utility system. Additionally, any generator system using a "closed transition" type transfer switch or a multi-breaker transfer scheme, or an electrical inverter that can be configured or programmed to operate in a "utility interactive mode" constitutes a potential backfeed source to the utility system, and is classified as an interconnected generator.

The utility has specific interconnection and contractual requirements that must be complied with, and information that needs to be submitted for all interconnected generators as is specified in the various sections of this document. In summary, these include a "visible open" disconnect switch meeting certain requirements to isolate the Customer's system from the utility system, as well as protective relaying, metering, special rate schedules, and other safety and information requirements. The Customer will be responsible for having the generation system protective schemes tested by qualified testing/calibration personnel. Utility personnel will inspect the system and the Customer will be required to sign an Interconnect Agreement and, as applicable, an Electric Supply/Purchase Agreement with the utility. Utility "blanket approval" is not extended to any specific type of generator or generator scheme since each project is site specific and needs to be reviewed on a case-by-case basis.

In addition to the various other requirements specified in this document, Parallel Systems shall specifically comply with the technical requirements outlined in the Interconnection Technical Requirements section (Section 8) of this document.

# 6. GENERAL INFORMATION & REQUIREMENTS

The Customer is responsible for all facilities required to be installed solely to interconnect the Customer's generation facility to the utility system. This includes connection, transformation, switching, protective relaying, metering and safety equipment, including a visibly-open Disconnect Switch and any other requirements as outlined in this document or other special items specified by the utility. All such Customer facilities are to be installed by the Customer at the Customer's sole expense. In the event that additional facilities are required to be installed on the utility system to accommodate the Customer's generation, the utility will install such facilities, generally at the Customer's expense. The utility may also charge the Customer for any administrative costs and/or the costs of studies required to interconnect the Customer's generation.

**(IT WAS PROPOSED THAT THE ACC MAY YET ADDRESS THE ISSUE OF ALLOCATION OF THESE COSTS. UTILITY COMMITTEE MEMBERS EXPRESSED CONCERN AT THIS SUGGESTION. UTILITIES PRESENTLY HAVE TARIFFS APPROVED BY THE ACC TO RECOVER ALL REASONABLE COSTS OF INTERCONNECTION SUCH AS SWITCHING, METERING, TRANSMISSION, SAFETY PROVISIONS AND ADDITIONAL ADMINISTRATION. CUSTOMERS ARE ALSO FULLY RESPONSIBLE FOR THE COSTS OF DESIGNING, INSTALLING, OPERATING AND MAINTAINING INTERCONNECTION FACILITIES. THESE TARIFFS ARE EVEN MORE CRITICAL AS WE ENTER COMPETITION, AND COSTS SHOULD BE BORNE BY THOSE WHO STAND TO BENEFIT FROM DG, NOT THROUGH RATES PAID FOR BY STANDARD OFFER OR DISTRIBUTION CUSTOMERS.)**

The Customer will own and be responsible for designing, installing, operating and maintaining:

(a) The generating facility in accordance with the requirements of all applicable electric codes, laws and governmental agencies having jurisdiction.

(b) Any control and protective devices, in addition to protective relays and devices specified in this document, to protect its facilities from abnormal operating conditions such as, but not limited to, electric overloading, abnormal voltages, and fault currents.

(c) Interconnection facilities on the Customer's premises as may be required to deliver power from the Customer's generating facility to the utility system at the Point of Interconnection.

## 6.1 Insurance

Customers interconnecting a generator with a utility may be required to maintain public liability and property damage insurance.

## 6.2 Interconnect Agreement

All interconnected Customers are required to sign, in addition to any other special agreements as may be applicable, an Interconnect Agreement with the utility.

## 6.3 Electric Supply/Purchase Agreement

Customers purchasing energy from either the utility or an ESP, utilizing an interconnected DG system, will be required to sign an agreement for backup, supplemental and maintenance power from their energy supplier.

The Customer must also sign an agreement/tariff with the appropriate utility for movement of power over the utility's distribution grid and transmission system.

For a Customer who wishes to sell power to others, the customer will be required to:

1) Choose a utility tariff that allows for the movement of power over the utility distribution grid and transmission systems;

2) Sign an agreement with the purchaser of the electric power , and/or

3) Become an ESP and sell power to retail customers. The Customer may sell power to the Customer's UDC, other utilities, ESPs, or electric wholesalers. These entities may or may not be obligated to purchase this power and any such sales would be made under the terms and conditions offered by the purchaser.

All tariffs under this Purchase/Supply Agreement are subject to change by the utility and approval of the ACC.

## 6.4 Interconnections

The utility will not install or maintain any lines or equipment on a Customer's side of the Point of Interconnection, except it may install its meter. Only authorized utility employees may make

and energize the service connection between the utility system and the Customer's service entrance conductors.

Normally, the interconnection will be arranged to accept only one type of standard service at one Point of Interconnection. If a Customer's generating facility requires a special type of service, or if sales to the utility will be at a different voltage level, the services will only be provided according to additional specific terms that are outlined in the Electric Supply/Purchase Agreement, applicable rate schedules, or other terms and conditions governing the service.

## 6.5 Easements and Rights of Way

Where an easement or right of way is required to accommodate the interconnection, the Customer shall provide, or obtain from others and provide, suitable easements or rights of way, in the utility's name.

## 6.6 Meter Installations

The utility has metering requirements for a GF that may depend on the electric rate tariff selected by the Customer. The Customer will need to contact the utility, or the ESP or MSP if applicable, for design requirements and installation details.

# 7. DESIGN CONSIDERATIONS AND DEFINITION OF CLASSES

Protection requirements are influenced by the size and characteristics of the parallel generator along with the nature and operational characteristics of the associated the utility system. Therefore, similar units connected to different lines could have different protection requirements based on varying load conditions, as well as on utility feeder and transformer characteristics.

## 7.1 Synchronous Units

Synchronous generators are generally capable of supplying sustained current for faults on the utility system. These units can also supply isolated utility load providing the load is within the units' output capability, and must be prevented from energizing a de-energized utility line.

Automatic reclosing by the utility may be either time-delayed or may be instantaneous. The utility will specify the maximum allowable protective relay time settings for a particular proposed distributed generator installation. The Customer is responsible for ensuring generator separation prior to utility circuit re-energization to prevent out-of-sync paralleling.

## 7.2 Induction Units

Induction generators are basically induction motors that are mechanically driven above synchronous speed to produce electric power. These units do not have a separate excitation system and, as such, require that their output terminals be energized with AC voltage and supplied with reactive power to develop the magnetic flux. Induction generators are therefore normally not capable of supplying sustained fault current into faults on the utility system. Such units are generally not capable of supplying isolated load when separated from the utility system; however, it is possible for an induction generator to become self-excited if a sufficient amount of capacitance exists at its output terminals. Under conditions of self-excitation, an induction generator will be capable of supplying isolated load, providing the load is within the units' output capability. In most cases when self-excitation occurs it will be accompanied by a sudden increase in terminal voltage. The utility and its other customers must be protected from out-of-sync closing and over-voltages that can occur whenever an induction generator becomes self-excited. Induction units shall therefore be designed to automatically separate from the utility system upon loss of utility voltage and prior to reclosing of the utility feeder.

## 7.3 Static Inverters

Static inverters convert DC power to AC by means of electronic switching. Switching can be controlled by the AC voltage of the utility's supply system (line-commutated) or by internal electronic circuitry (forced-commutated). Line-commutated inverters are generally not capable of operating independently of the utility's AC supply system and, as such, cannot normally supply fault current or isolated loads. Forced-commutated, or self-commutated, inverters are capable of supplying fault current and load independently of the AC supply system. Any forced-commutated inverter that is to be interconnected with the utility must be specifically designed for that purpose, i.e. it must be designed to accommodate parallel interfacing and operation. Static inverters must be designed to automatically separate from the utility system upon loss of utility voltage and prior to reclosing of the utility feeder.

## 7.4 Definition of Generator Size Classes

The following generator size classifications are used in determining specific minimum protective requirements for distributed generation facilities. Specified ratings are for each connection to the utility system. Customers must satisfy, in addition to the general requirements specified in this document, the minimum relaying requirements given in this document for each generator class.

(a) Class I -- 50 kW or less, single or three phase
(b) Class II -- 51 kW to 300 kW, three phase
(c) Class III -- 301 kW to 5,000 kW, three phase
(d) Class IV -- over 5,000 kW, three phase

# 8. INTERCONNECTION TECHNICAL REQUIREMENTS

The requirements and specifications outlined in this section are applicable to distributed generation interconnected for parallel operation with the utility distribution system, unless otherwise specified. The protection and safety devices and other requirements specified in the following sections are intended to provide protection for the utility system, utility workers, other utility customers and the general public. They are not imposed to provide protection for the Customer's generation equipment or personnel; this is the sole responsibility of the Customer.

With respect to the above protection objectives, it is necessary to disconnect the parallel generator when trouble occurs. This is to:

(a) ensure if a fault on the utility system persists, the fault current supplied by the Customer's generator is interrupted;
(b) prevent the possibility of reclosing into an out-of-synch isolated system composed of the utility distribution system, or a section thereof, and the Customer's generator; and
(c) prevent reclosing into the Customer's generation system that may be out of synchronization or stalled.

The protection requirements are minimal for smaller installations, but increase as the size of the Customer's generation increases. Small installations usually ensure that the generator is small compared with the magnitude of any load with which it might be isolated. Thus, for any fault on the utility system, utility protective devices will operate and normally isolate the generation with a large amount of load, causing under-voltage automatic shutdown of the generator. For larger installations the probability of isolated operation is higher since the available generation may be sufficient to carry the entire load, or part thereof, of the local utility circuit. In instances where the utility system arrangement is such that it is possible that the generators will not always be isolated with comparatively large amounts of load, additional protection and generator shutdown schemes are required.

**The Customer is solely responsible for the protection of his equipment from automatic reclosing by the utility**. The utility normally applies automatic reclosing to overhead distribution circuits. When the utility source breaker trips, the Customer must ensure that his generator is disconnected from the utility circuit prior to automatic reclosure by the utility the automatic reclosing time on the utility distribution varies by utility, and from utility feeder to feeder. Automatic reclosing out-of-synch with the Customer's generator may cause severe damage to Customer equipment and could also pose a serious hazard to Customer or utility personnel.

## 8.1 General Technical Requirements

8.1.1 Customer is responsible for obtaining and maintaining all required permits and inspections indicating that Customer's generating facility complies with all applicable codes, ordinances and statutes relating to safety and construction.

8.1.2 Multiple generator connections on the same utility service are permitted; however, a single Disconnect Switch for the facility will generally be required (normally located at the service entrance section).

8.1.3 In the event that a generator, or aggregate of generators, are of sufficient size to carry the entire (minimum) load of the utility distribution feeder, or if a generator size and physical location on a feeder is such that it could support an isolated (islanded) section of the feeder, then a transfer trip scheme may be required at the Customer's expense. If a transfer trip is required, a communication channel and telemetering may also be required, at the Customer's expense, to facilitate proper parallel operation. In certain instances, a dedicated utility feeder may be required.

8.1.4 For synchronous generators, the Customer shall ensure that any potential open points such as breakers, fused disconnect switches, etc, located between the generator breaker and utility service are appropriately equipped with either (1) keyed or other suitable mechanical interlocks to prevent them from being inadvertently opened when the generator breaker is closed, or (2) contacts that will instantaneously trip the generator breaker if any such switch were opened while the generator breaker was closed.

The intent of the above is to prevent the opening and subsequent (inadvertent) re-closing of such a breaker or switch onto an un-synchronized generator.

8.1.5 Customer shall ensure that the design and installation of electric meter(s) is such that the meter(s) are located on the utility-side of the generator breaker on a normally energized bus. Electronic meters are not designed to be de-energized for any length of time.

8.1.6 The Customer is responsible for the design, installation, operation and maintenance of all equipment on the Customer's side of the Point of Interconnection. It is strongly recommended that the Customer submit specifications and detailed plans as specified in the Application and Equipment Information Form (refer to Appendix A) for the installation to the utility for review and written approval prior to ordering any equipment. Written approval by the utility does not indicate acceptance by other authorities.

## 8.2 Disconnect Switch

The Customer shall install and maintain a visible open, manually-operated load-break disconnect switch ("Disconnect Switch") capable of being locked in a visibly "open" position by a standard utility padlock that will completely open and isolate all ungrounded conductors of the Customer's generating facility from the utility system. For multi-phase systems, the switch shall be gang-operated.

The Disconnect Switch blades, jaws and the air-gap between them shall all be clearly visible when the switch is in the "open" position. It is not acceptable to have any of the "visible open" components obscured by the switch case or an arc-shield, etc. Only switches specifically designed to provide a true "visible open" are acceptable. Such Disconnect Switch shall be installed in a place so as to provide easy and unrestricted accessibility to utility personnel on a 24-hour basis. The utility shall have the right to lock open the Disconnect Switch without notice to the Customer

when interconnected operation of the Customer's generating facility with the utility system could adversely affect the utility system or endanger life or property, or upon termination of the Interconnect Agreement.

The Disconnect Switch will normally be required to be installed at the Customer's electrical service entrance section; however it may be located in the immediate vicinity of the generator, subject to utility approval.

The Disconnect Switch must be rated for the voltage and current requirements of the generation facility, and must meet all applicable UL, ANSI and IEEE standards. The switch shall meet the requirements of the National Electric Code (NEC), and the switch enclosure shall be properly grounded.

In cases where the Disconnect Switch will be installed on a line at a voltage above 500V, the utility may have specific grounding requirements that will need to be incorporated into the Disconnect Switch. Under certain circumstances (above 500V, switch located outdoors and underground fed), the utility may require the customer to install a rack-out breaker, along with a racking tool and grounding breaker, in lieu of a Disconnect Switch. In these cases, the utility will work with the Customer to determine the best option and ensure that the safety requirements are met.

## 8.3 Dedicated Transformer

Customer generators with a combined total rating of over 10 kW, as measured at the service entrance, may be required to be isolated from other customers fed off the same utility transformer by a dedicated power transformer connecting to the utility distribution feeder. The primary purpose of the dedicated transformer is to ensure that (a) the generator cannot become isolated at the secondary voltage level with a small amount of other-customer load, and (b) the generator does not contribute any significant fault current to other customers' electrical systems. It also helps to confine any voltage fluctuation or harmonics produced by the generator to the Customer's own system. The utility will specify the transformer winding connections and any grounding requirements based on the specific customer site location.

## 8.4 Power Quality

Customer shall exercise reasonable care to assure that the electrical characteristics of its load and generating equipment will maintain the serving utility's normal power quality requirements. Any deviation from sine wave form or unusual short interval fluctuations in power demand or production shall not be such as to result in impairment of service to other customers or in interference with operation of computer, telephone, television or other communication systems or facilities. Those power quality items will generally include the following:

- Power Quality
- Current Imbalance
- Harmonics
- Voltage Flicker

Exhibit 1 lists for general informational purposes currently available requirements for APS, SRP, TEP and SSVEC, and may be updated from time to time. The Customer should verify actual requirements with the serving utility prior to designing/installing a GF.

**(CERTAIN COMMITTEE MEMBERS RECOMMEND THAT THE ACC SHOULD ADOPT A STATEWIDE STANDARD FOR POWER QUALITY ISSUES MEASURED AT THE POINT OF INTERCONNECTION, AND APPLICABLE WHETHER OR NOT A GF IS INSTALLED ON THE CUSTOMER SITE. OTHER COMMITTEE MEMBERS FEEL THAT THIS CAN NOT BE READILY STANDARDIZED DUE TO DIFFERENCES IN UTILITY SYSTEM DESIGN AND OPERATION.)**

## 8.5 Voltage Requirements

Customer generating equipment must deliver at the Point of Interconnection, 60 Hertz, either single or three-phase power at one standard utility voltage as may be selected by the Customer subject to availability at the premises.

## 8.6 Labeling Requirements

### 8.6.1 General Requirements

The Customer shall conform to the NEC for labeling of generation equipment, switches, breakers, etc. The utility will assume the responsibility for labeling any utility equipment.

### 8.6.2 Disconnect Switch

The Customer shall label the Disconnect Switch "Interconnected Generator Disconnect Switch" (or "Interconnected Photovoltaic Inverter Disconnect Switch, Interconnected Wind Turbine Disconnect Switch", etc., as the case may be) by means of a permanently attached placard with clearly visible and permanent letters**.** In addition, the utility may need to attach its own label to the Disconnect Switch.

### 8.6.3 Service Entrance

A sign shall be placed at the service entrance indicating type and location of onsite emergency power sources, legally required standby power sources, and onsite optional standby power sources, as defined by the NEC.

The NEC also requires a permanent directory, denoting all electrical power sources on or in the premises, shall be installed at each service equipment location and at locations of all electric power production sources capable of being interconnected. Installations with large numbers of power production sources shall be permitted to be designated by groups.

## 8.7 Protective Requirements

### 8.7.1 General Requirements

8.7.1.1 The Customer shall be solely responsible for properly protecting and synchronizing his generator(s) with the utility system.

8.7.1.2 Customer facility shall include an automatic interrupting device that is listed with a nationally recognized testing laboratory, and is rated to interrupt available fault (short circuit) current. The interrupting device shall be tripped, as a minimum, by all protective devices required herein.

8.7.1.3 Inherent characteristics of induction disk type voltage and frequency relays render their use unsuitable for some generator interface protection applications. Therefore, devices with definite level and timing characteristics (e.g., solid state type relays) will be necessary to meet the requirements established herein.

8.7.1.4 For generator classes II and above (>50 kW), utilizing discreet relays, separate and independent voltage and frequency relays and associated trip paths to the generator breaker (automatic interrupting device) are required. This is to ensure a redundant trip function in the event of a single relay failure or out-of-tolerance condition. It is acceptable however, for the over/under voltage functions to be integrated into a single o/u voltage relay, and for the over/under frequency functions to be integral to a single
o/u frequency relay. Protective relays or microprocessor based devices may be used provided that the required functionality described herein is demonstrated.

8.7.1.5 For generator protective schemes that utilize microprocessor based, multi-function relays, one of the following requirements must be met:

(a) Protective relay failure will not only alarm but will also trip the generator breaker/contactor.

(b) If relay failure alarms, but does not trip the generator breaker, then additional relaying which meets the requirements stated herein for each class must be provided.

8.7.1.6 With the addition of generation at a Customer site, the ground fault current magnitude might increase to the level where the grounding grid is insufficient to protect personnel from step or touch potentials. Therefore, a study may be required to ensure the adequacy of the Customer's grounding grid to keep the step and touch potentials at a safe level.

8.7.1.7 The Customer shall ensure that the GF protective relaying and controls are adequately protected from electrical surges that may result from lightning, utility switching or electrical faults.

### 8.7.2 **Generator Class Protective Requirements**

#### 8.7.2.1 **Class I (Single or Three Phase: 50 kW or less)**

1. The minimum protection required is an under-voltage contactor.

2. For all synchronous generators and forced commutated inverters, either a manual or automatic synchronizing scheme is required.

#### 8.7.2.2 **Class II (Three Phase: 51-300 kW)**

1. Protection for overvoltage, undervoltage, overfrequency, and underfrequency is required.

2. For all synchronous generators and forced commutated inverters, either a manual or automatic synchronizing scheme is required.

3. For installations interconnected to the utility through a transformer with connections that will not supply current to a ground fault on the utility system, a special ground fault detection scheme may be necessary. The utility will advise Customer of any such requirements after a preliminary review of the Customer's proposed installation.

4. Other equipment such as supervisory control and alarms, telemetering and associated communications channel may be necessary. This is especially the case when (a) the generator, or an aggregate of generators is large relative to the minimum load on a feeder or sectionalized portion of the feeder, (b) the GF is involved in power transactions requiring the grid, or (c) the GF is remotely controlled by, or dispatched by the utility. The utility will advise Customer of any communications requirements after a preliminary review of the proposed installation.

#### 8.7.2.3 **Class III (Three Phase: 301-5,000 kW)**

1. For this class of installation, utility grade protection devices and equipment will be required.

2. Protection for overvoltage, undervoltage, overfrequency, and underfrequency is required.

3. For all synchronous generators and forced commuted inverters, either a manual or automatic synchronizing scheme is required.

4. For installations interconnected to the utility through a transformer with connections that will not supply current to a ground fault on the utility system, a special ground fault detection scheme may be necessary. The utility will advise Customer of any such requirements after a preliminary review of the Customer's proposed installation.

5. Other equipment such as supervisory control and alarms, telemetering and associated communications channel may be necessary. This is especially the case when (a) the generator, or an aggregate of generators is large relative to the minimum load on a feeder or sectionalized portion of the feeder, (b) the GF is involved in power transactions requiring the grid, or (c) the GF is remotely controlled by, or dispatched by the utility. The utility will advise Customer of any communications requirements after a preliminary review of the proposed installation.

8.7.2.4 **Class IV (Three Phase: Greater than 5,000 kW)**

Note: Induction Generators or Line Commuted Inverters (LCI) in this size range are not anticipated.

1. For this class of installation, utility-grade protective devices and equipment will be required.

2. Protection for overvoltage, undervoltage, overfrequency, and underfrequency is required.

3. For all synchronous generators and forced commuted inverters, either a manual or automatic synchronizing scheme is required.

4. A ground time overcurrent and instantaneous overcurrent relay, or for installations interconnected to the utility through a transformer with connections that will not supply current to a ground fault on the utility system, a ground fault detection scheme is required.

5. The following relays are also required:

   (a) Voltage-controlled time overcurrent relays, one per phase
   (b) Negative sequence time overcurrent relay
   (c) Overexcitation relay
   (d) Loss of excitation relay

6. Other equipment such as supervisory control and alarms, telemetering, and associated communications channel may be necessary. This is especially the case when (a) the generator, or an aggregate of generators is large relative to the minimum load on a feeder or sectionalized portion of the feeder, (b) the

GF is involved in power transactions requiring the grid, or (c) the GF is remotely controlled by, or dispatched by the utility. The utility will advise Customer of any communications requirements after a preliminary review of the proposed installation.

The minimum protective relaying requirements for parallel operation of distributed generation are summarized in the following table:

**Summary of Minimum Protective Relaying Requirements**

| | Induction Generator/<br>Line Commutated Inverter | Synchronous Generator/<br>Forced Commutated Inverter |
|---|---|---|
| Class I<br>50 kW or less | Undervoltage contactor | Undervoltage contactor<br>Synchronizing |
| Class II<br>51 to 300 kW | Overvoltage, Undervoltage<br>Overfrequency,<br>Underfrequency | Overvoltage, Undervoltage<br>Overfrequency, Underfrequency<br>Synchronizing |
| Class III<br>301 to 5,000 kW | Overvoltage, Undervoltage<br>Overfrequency,<br>Underfrequency | Overvoltage, Undervoltage<br>Overfrequency, Underfrequency<br>Synchronizing |
| Class IV<br>Greater than<br>5,000 kW | No induction generators of this size anticipated | Overvoltage, Undervoltage<br>Overfrequency, Underfrequency<br>Synchronizing<br>Ground Time Overcurrent<br>Ground Instantaneous Overcurrent<br>Voltage-controlled Time Overcurrent<br>Loss of Excitation<br>Overexcitation<br>Negative Sequence Time Overcurrent |

### 8.7.3 **Relay Settings**

Voltage and frequency relays needed for minimum interface protection for all classes will have setting limits as specified by the serving utility. Exhibit 2 lists for general informational purposes currently available settings for APS, SRP, TEP and SSVEC, and may be updated from time to time. The Customer should verify with the serving utility prior to designing/installing a GF.

# 9. APPLICATION PROCESS AND DOCUMENTATION REQUIREMENTS

9.1 Utility approvals given pursuant to the review and approval process and the Interconnection Agreement shall not be construed as any warranty of representation to Customer or any third party regarding the safety, durability, reliability, performance or fitness of Customer's generation and service facilities, its control or protective device or the design, construction, installation or operation thereof.

9.2 The "Application and Equipment Information Form" (see Appendix A) must be completed by the Customer and all supplementary information requested therein must be provided to the utility for review.

The utility strongly encourages each Customer to contact and work closely with the utility at the conceptual stages of the design to ensure that the project proceeds smoothly. The utility will generally require a single point of contact with which to coordinate the interconnection process and a single utility point of contact will be provided to the Customer. Exhibit 3 lists for general informational purposes the typical steps required to interconnect a DG with a utility.

9.3 In the event it is necessary for the utility to install interconnection facilities on its system (including but not limited to control or protective devices, or any other facilities), in order to accommodate or protect the Customer's generation facility or utility equipment, the utility will inform the Customer of the cost and generally the Customer must reimburse the utility for the costs incurred by the utility to the extent they exceed those normally incurred by the utility for customers who do not have self generation facilities.

9.4 Following the utility's approval of the Customer's proposed generating facility and associated facilities, the Customer cannot remove, alter or otherwise modify or change the equipment specifications, including, without limitation, the operational plans, control and protective devices or settings, and the generating facility system design, type, size or configuration. If the Customer desires to make such changes or modifications, the Customer must revise and resubmit to the utility plans describing the changes or modifications for approval by the utility. No change or modification may be made without the prior written approval of the utility.

# 10. TESTING AND START-UP REQUIREMENTS

10.1 Following the utility approval of the Customer's interconnection equipment and protective devices as specified herein, the Customer shall, at a minimum, have all specified interface equipment, shutdown and associated protective devices field tested and calibrated at the time of installation by qualified personnel and shall also perform functional trip testing of these relays and associated generator or inverter breaker. Calibration shall include on-site testing of trip setpoints and timing characteristics of the protective functions as required herein. Functional testing must demonstrate that each protective relay or device trip function as required herein, upon a (simulated) out of tolerance input signal will trip the generator breaker, and shall also include a simulated loss of control power to demonstrate that the generator breaker or contactor will open.

A trip timing test (simulated loss of voltage) will suffice for static inverters rated 50kW or less.

10.2 The Customer shall provide the utility with a copy of calibration and functional test results. Customer must also notify the utility at least five working days in advance that such tests are to be performed and allow utility personnel to witness such tests and/or conduct additional startup tests if necessary.

10.3 The Customer shall be required to have a signed Interconnect Agreement with the utility, and will need to provide the utility with a copy of the insurance certificate, as applicable, prior to electrically paralleling the generating facility with the utility system.

10.4 The Customer shall not commence interconnected operation of its generating facility until the installation has been inspected by an authorized utility representative and final written approval is received from the utility to commence interconnected operation, which approval shall not be unreasonably withheld. The Customer shall give the utility at least five working days notice as to when initial startup is to begin. The utility will have the right to have a representative present during initial energizing and testing of the Customer's system.

10.5 The Customer shall have all protective devices tested by qualified test personnel at the time of installation, prior to initial interconnection, and at intervals not to exceed four years. The Customer shall (i) notify the utility as to when such tests are to be performed at least five working days prior to such tests and allow the utility personnel to witness the testing, and (ii) provide the utility with a certified copy of the test results.

# 11. OPERATIONAL AND MAINTENANCE REQUIREMENTS

11.1 The Customer shall be responsible for operating and maintaining the generator facility in accordance with the requirements of all applicable safety and electrical codes, laws and governmental agencies having jurisdiction.

11.2 The Customer shall protect, operate and maintain the generating facility in accordance with those practices and methods, as they are changed from time-to-time, that are commonly used in prudent engineering practice and shall operate and maintain the generating facility lawfully in a safe manner and non-hazardous condition.

11.3 In the event the utility or its authorized agents lock open the Disconnect Switch, the Customer shall not remove or tamper with such lock.

11.4 The utility (including its employees, agents and representatives) shall have the right to enter the Customer's premises to (a) inspect the Customer's generating facility, protective devices, and to read or test instrumentation equipment that the utility may install, provided that as reasonably as possible, notice is given to the Customer prior to entering its premises; (b) maintain or repair the utility equipment; (c) disconnect the generating facility without notice if, in the utility's opinion, a hazardous condition exists and such immediate action is necessary to protect persons, the utility facilities or other customers' or third parties' property and facilities from damage or interference caused by the Customer's generating facility, or improperly operating protective devices; (d) open the Disconnect Switch without notice if an operating clearance or hold tag is required by utility personnel.

11.5 Following the release of a utility clearance or hold tag, where it was necessary for the utility to open the Disconnect Switch, utility personnel will not normally re-close the switch. It will normally be the Customer's responsibility to re-close the switch after ensuring that all generation sources that could potentially be energizing the Customer's side of the switch are off, so as to eliminate any possibility of re-closing the utility grid onto an out-of-sync generator.

However, utility personnel may, without liability, re-close the Disconnect Switch provided that (a) Customer requests, and agrees to allow, the utility to re-close the switch, following the release of a utility clearance or hold tag, and (b) there are means provided to conveniently allow utility personnel to verify that the Customer side of the Disconnect Switch is not energized.

11.6 Upon termination of the Interconnect Agreement, the Customer shall be responsible for ensuring that the Disconnect Switch is immediately opened, and that the electric conductors connecting the Customer's generator(s) to the Disconnect Switch are physically removed, so as to preclude any possibility of inadvertent interconnected operation in the future. The utility reserves the right to inspect the Customer's facility to verify that the generator is appropriately disconnected.

## APPENDIX A

## APPLICATION AND EQUIPMENT INFORMATION FORM

**SITE AND CUSTOMER INFORMATION**
(Complete all items)

Customer Name _____ Telephone _____

Company Name (if applicable) _____

Mailing Address _____

Generating Facility Address _____

Project Contact _____ Telephone _____

Utility Account Number _____ Electric Meter No. _____

ESP (if different from serving utility) _____

MSP (if different from serving utility) _____

Completed By _____ Telephone _____

**PROPOSED OPERATION**
(Answer all questions)

A. Is the Generation Facility a Qualifying Facility (QF) as defined in the Definitions section of the document? (Yes or No) _____.

B. Does the Generation Facility plan on being a net exporter of energy into the utility grid? (Yes or No)_____. If "Yes", explain the proposed operation and estimated power to be exported, and also provide name of proposed purchaser of this power:

_____

_____

C. If the Generating Facility will be used only to displace utility power, will it be operated as a peak-shaving or base-loaded unit?

_____

_____

_____

**GENERATOR INFORMATION**
(Complete for each rotating generator only)

A. Manufacturer _____

B. Type (Synchronous, Induction, D.C.) _____

C. Nameplate rating
Voltage _____ kW _____
Power Factor _____ Frequency _____
Model No. _____ Single or Three Phase _____

D. Type of Excitation System (Self or Separate) _____

E. Generator Electrical Characteristics (on the machine base, for Class II and above)

Synchronous Reactance (X'd) _____
Transient Reactance (X'd) _____
Subtransient Reactance (X"d) _____
Zero sequence reactance (XO) _____
Negative sequence reactance (X2) _____

**PRIME MOVER**
(Complete for rotating machinery only)

A. Manufacturer _____
B. Manufacturer's Reference Number _____
C. Energy Source (Natural Gas, Steam, etc.) _____

**INTERFACE EQUIPMENT**
(Complete for each rotating generator only)

A. Synchronizer for Synchronous Generator:
Manufacturer _____
Manufacturer's Model Number _____
Automatic or Manual Synchronizer _____

B. Inverter for DC generator:
Manufacturer _____
Manufacturer's Model Number _____
Line or Self Commutated Inverter _____

**STATIC INVERTER**
(Complete for DC to AC Inverters only)

A. Manufacturer _____ Model No. _____
B. Terminal Voltage _____ Single, Split or Three Phase _____
C. Nameplate kW _____ No. of Units _____
D. Frequency _____ Power Factor _____
E. Line or Self Commutated _____ Battery Back Up? _____
F. Total System kW Output _____
G. Energy or Fuel Source _____

**PROTECTION EQUIPMENT**
(Complete all applicable items, attach a separate sheet if necessary)

A. Manufacturer's Name for each Protective Device _____
_____
_____

B. Manufacturer's Model Number for each Protective Device _____
_____
_____

C. Range of Available Settings for each Protective Device _____
_____
_____

D. Proposed Settings (trip setpoint and time) for each Protective Device _____
_____
_____

E. Ratios of associated current transformer. If multi-ratio, state the available ratios and which ratio will be used _____
_____

F. Describe operation for tripping of the interface or generator circuit breaker for both

1. Utility outage _____
_____
_____

2. Utility short circuit (three phase and single phase to ground) _____
_____
_____

**SUPPLEMENTARY INFORMATION**

(Information below to be submitted for all projects. All diagrams are to be professionally and neatly drawn. Generally, free hand drawn or illegible diagrams will not be accepted by utility).

A. Electrical One-Line Diagram:

Provide 5 sets, including any and all revisions or changes as they are made. Diagram(s) must also include project name and address, show generator size and all protective relaying and control equipment, as well as electric service entrance and utility meter.

B. Electrical Three-Line Diagram:

Provide 5 sets, including any and all revisions or changes as they are made. Diagram(s) must also include project name and address, show generator size and all protective relaying and control equipment, as well as electric service entrance and utility meter, and include all neutral and ground conductors and connections.

C. AC & DC Control Schematics:

Provide 5 sets, including any and all revisions or changes as they are made, for all projects comprising rotating machinery. Diagrams must show the detailed wiring of all protective relays and control functions, and include control power source and wiring.

D. Detailed Map:

Provide 5 sets of detailed maps, including any and all revisions or changes as they are made. Maps should show major cross streets and proposed plant location, and include the street address.

E. Site Plan:

Provide 5 sets of site plans, including any and all revisions as they are made, showing the arrangement of the major equipment, including the electric service entrance section and utility meter, location of generator and interface equipment, and location of the Disconnect Switch. Include the street address, and location of the any lock-boxes, etc.

F. Testing Company:

Provide the name of the company that will do the protective relay bench testing and the trip circuit functional tests and the anticipated start up date.

G. Point of Contact

If the interconnection and start-up process is to be coordinated through a party or individual other than the Customer, provide the name, company, address and phone number of that individual or party with whom the utility is to coordinate the interconnection.

## EXHIBIT 1

## LOAD CHARACTERISTICS FOR ARIZONA UTILITIES LAST UPDATE NOVEMBER, 1999

| SETTING TYPE | APS | SRP | TEP | SSVEC |
|---|---|---|---|---|
| Power Factor [1] | 90% lag<br>0% lead | 85% lag to<br>90% lead | No<br>Penalties | 90% lag<br>90% lead |
| Phase Current Imbalance | 10% | 5% | [3] | 10% |
| Voltage Characteristics | ANSI C84.1 | [2] | ANSI C84.1 | ANSI C84.1 |
| Sine Wave Form | IEEE 519 | [2] | IEEE 519 | IEEE 519 |
| Harmonics | IEEE 519 [2] | IEEE 519 [2] | IEEE 519 [2] | IEEE 519 [2] |
| Voltage Flicker | IEEE 519 [3] | IEEE 519 [3] | IEEE 519 [3] | IEEE 519 [3] |

**Notes:**

[1] Provision to substitute kVA for kW in rates but not generally applied.

[2] Load characteristics shall not impair service to other customers.

[3] Need to consult utility.

## EXHIBIT 2

## UTILITY RELAY SETTINGS AND RE-CLOSING PRACTICES LAST UPDATE NOVEMBER, 1999

| SETTING TYPE | APS | SRP | TEP | SSVEC |
|---|---|---|---|---|
| Over-frequency Time delay | 62 Hertz<br>1 Second | [1] | 61.1 Hz<br>0.1 Seconds | 60.5 Hz<br>0.1 Seconds |
| Under-frequency Time delay [2] | 58 Hertz<br>1 Second | [1] | 58.9 Hz<br>0.1 Seconds | 59.5 Hz<br>0.1 Seconds |
| Over-voltage Time Delay | 120%<br>1 Second | 120%<br>0 Seconds | 105%<br>0 Seconds | 110%<br>1 Seconds |
| Under-voltage Time Delay | 80%<br>1 Second | 90%<br>[3] | 95%<br>0 Seconds | 90%<br>1 Second |
| Re-closing, first shot [4] | 2 or 5 Seconds | Instantaneous | Instantaneous | 1 to 2 Seconds [6] |
| Re-closing, second shot [4] | 2 or 5 Seconds | 15 Seconds | 15 to 30 Seconds [5] | 1 to 2 Seconds |
| Re-closing, third shot [4] | 5 Seconds | | 165 Seconds | 1 to 5 Seconds |
| Re-closing, fourth shot [4] | 5 Seconds | | | |

**Notes:**

[1] Guidelines do not specify a setting or time delay; they say "trip the circuit breaker when the frequency varies from the nominal 60 Hz."

[2] If generator is considered a WSCC generator, the under-frequency setting might be different to comply with WSCC guidelines.

[3] Per SRP guidelines, "Set the time delay (typically 3 to 5 seconds at zero voltage) to allow for motor starting and to coordinate with line protection devices."

[4] Times are for typical overhead/residential type feeders (not necessarily line reclosers), and are the time delay from the trip to the next reclosure. Actual number of re-close shots on a particular feeder may vary.

[5] Varies based on type of reclosing utilized.

[6] Reclosing on first shot transmission, and hence distribution, is instantaneous.

## EXHIBIT 3

## DG APPLICATION PROCESS

**Step 1 –** Customer contacts Utility for interconnection information package and outlines proposed project. Utility forwards appropriate information to Customer within five (5) working days and provides a Utility contact name and number should Customer decide to proceed with project.

**Step 2 – (OPTIONAL STEP)** If Customer decides to proceed with project, Customer is strongly encouraged to contact Utility at conceptual stage of project and discuss proposed installation/design options with the Utility. Customer is encouraged to meet with Utility and discuss the type and size of system, location and proposed operation. A preliminary electrical one-line diagram would be very helpful at this stage. This step will help ensure that :

1. The project proceeds smoothly and in a timely fashion helping to mitigate any surprises later on.
2. It will help the Utility determine upfront if any special studies may be required, which could be initiated as early on as possible.
3. Applicable interconnect and protective requirements are properly understood and implemented.

**(REGARDING POINT 3 ABOVE, PERHAPS A REVIEW OF THE STATEWIDE INTERCONNECT STANDARDS AS APPLICABLE TO THE SUBJECT PROJECT WOULD BE APPROPRIATE AT THIS POINT.)**

**Step 3** – Customer proceeds with design and prepares the utility-required information – application form, electrical diagrams, protective relaying and settings, site equipment and layout plans, etc. It is strongly suggested, especially on large projects (above 50 kW) that these be submitted/discussed, normally on an informal basis, with the Utility as they are developed, so the Utility can make any comments or recommendations as early on in the design process as possible – this is normally an interactive and iterative process, at which point Customer may need to submit data to the Utility if any special studies are required, and Utility may also need to submit fault/coordination information to Customer as required.

**(ALTHOUGH IT IS UNDERSTOOD THAT THE WORDS "INFORMAL BASIS" ARE USED TO RECOGNIZE THAT THE ITERATIVE PROCESS WILL BE MOST PRODUCTIVE, THE PRACTICES OF INSTITUTIONAL CUSTOMERS ALSO NEED CONSIDERATION. MOST OF THESE CUSTOMERS UNDERTAKE FREQUENT DESIGN, PROCUREMENT, AND CONSTRUCTION PROJECTS. MILESTONES FOR REVIEW SUBMITTALS ARE TYPICALLY IDENTIFIED ON EACH PROJECT TIMELINE. PLEASE EMPHASIZE THAT THE DISTRIBUTION COMPANY REPRESENTATIVE SHALL BE INCLUDED IN ANY SCHEDULED REVIEW SUBMITTALS. FORGETTING TO GET OUTSIDE CONTACTS IN THE LOOP IS A VERY COMMON AND OFTEN FATAL FLAW FOR INSTITUTIONAL PROJECT MANAGERS AND SHOULD NOT BE TOLERATED HERE.**

**THE UTILITY WILL NEED TO SUBMIT FAULT CURRENT AND COORDINATION REQUIREMENTS BEFORE THE CUSTOMER CAN PROCEED WITH DESIGN DEVELOPMENT. PERHAPS AT THE TAIL END OF THE CONCEPTUAL PHASE IF THE PROJECT IS TO PROCEED, OR AT THE LATEST AT THE VERY BEGINNING OF DESIGN DEVELOPMENT.)**

Due to the diverse nature of projects, timeframes may need to be worked out between the Customer and the Utility, especially if special studies are required.

**Step 4** – Upon completion of the design, the Customer submits the final design package (as specified in the Application Form of the Interconnect Requirements manual) to the Utility for final review and approval. Customer notifies Utility interconnection contact that information has been submitted, and Utility reviews information and informs Customer within ten (10) working days of receipt as to sufficiency of information and whether any information is missing.

**Step 5** – Upon receipt of completed and sufficient application information, Utility reviews the application for conformance to the interconnect requirements within twenty (20) working days, unless other timeframes are mutually agreed upon. Utility will respond to Customer within this time as to whether the submitted design information complies with the interconnect requirements or if there are any issues in non-compliance. (In the event of non-compliance, Customer will re-submit corrected information and Step 5 will be re-initiated).

**Step 6** – Upon Customer receiving approval of the Utility for the design, construction of the facility commences, and the Utility prepares the required interconnection agreements and site checklist. **(SUGGEST ALLOWING THE CUSTOMER TO PREVIEW A SAMPLE SITE CHECKLIST DURING STEP 2 CONCEPTUAL PHASE ABOVE, PERHAPS WHEN THE INTERCONNECT STANDARDS ARE REVIEWED.)** Customer notifies Utility as to anticipated startup/testing date.

**Step 7** – Utility forwards completed interconnection documents/agreements to Customer for signature prior to anticipated startup date given in Step 6 above.

**Step 8** – Following construction/installation of the facility, Customer provides the Utility with at least ten (10) working days notice as to when the Utility can perform the site inspection and when the protective device tests, as applicable are to be performed so that the Utility may witness and/or review them.

**Step 9** – Upon satisfactory completion of the site inspection, protective relay testing, and signed interconnect documents, Utility notifies Customer in writing within two (2) working days that the facility may be operated in parallel with the Utility grid per the agreed terms and conditions.

**(SEVERAL UTILITIES HAVE EXPRESSED THAT THEY ARE NOT IN AGREEMENT WITH THE TIME LIMITS IMPOSED IN THE STEPS ABOVE. SOME UTILITIES DO NOT HAVE THE ENGINEERING STAFF ON HAND TO MEET THE ABOVE TIMELINES. OTHER COMMITTEE MEMBERS BELIEVE THIS SHOULD BE AN INTERACTIVE AND ITERATIVE PROCESS TO ENSURE THAT PROJECTS PROCEED SMOOTHLY.)**