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July 29, 2005

Docket Control
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

RE: Distributed Generation Workshop
Docket No. E-00000A-99-0431

Dear Sir/Madam:

Attached please find Arizona Public Service Company's ("APS'") comments submitted in the above matter.

In responding to Staff's assignment within the timeframe provided, APS has chosen to incorporate the technical interconnection requirements contained in the Arizona Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99) as well as sections of APS' current Interconnection Requirements for Distributed Generation, which requirements APS believes should be used to develop the statewide interconnection requirements in the current ACC Working Group process. APS supports many of the provisions included in the Texas Procedures Manual and the Small Generator Interconnection Procedures (SGIP) and Interconnection Agreements (SGIA) adopted by the Federal Energy Regulatory Commissoin (FERC).

APS is currently working on the development of a statewide interconnection requirements "strawman" that incorporates many of the provisions from the above-mentioned documents and is consistent with the FERC SGIPand SGIA. APS plans to distribute a draft version of this document prior to the next scheduled Working group meeting on August 26, 2005.

If you have any questions, please give me a call at 602-250-3933.

Sincerely,

David Rumolo/vld

David Rumolo, Manager
Regulation & Pricing

DR/vld

Cc: Docket Control (Original, plus 13 copies)
Erinn Andreasen
Lori Miller

Arizona Public Service Company
Distributed Generation Comments on Topics

I. Scope and Procedure

A. Applicability:

1. Size and Type of Facilities Which the Policy Applies to:

These provisions specify the minimum requirements for safe and effective operation of distribution generating facility interconnected (or paralleled) with a UDC's radial distribution system (21 kV or less).

However, these Provisions do not apply to interconnections with facilities of any size that are already subject to APS' Open Access Transmission Tariff ("OATT") at the time the interconnection request was made.

2. Categories of Generator Size or Classes:

The following size classifications are used in determining specific minimum protective requirements for the Generating Facility. Specified ratings are for each connection to the UDC's system. Interconnection Customers must satisfy, in addition to the general requirements specified in these provisions, the minimum relaying requirements provided herein for each generator class.

(i) Class I -- 50 kW or less, single or three phase
(ii) Class II -- 51 kW to 300 kW, three phase
(iii)Class III -- 301 kW to 5,000 kW, three phase
(iv)Class IV -- over 5,000 kW, three phase

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 7.4.

3. Distributed Generation Types:

Distributed generation is any type of generator or generating facility which has the potential (a) for feeding an Interconnection Customer load, where this load can also be fed by, or connected to, the UDC's electrical distribution system, or (b) for electrically paralleling with, or for feeding power back into the UDC's electrical distribution system.

A Generating Facility includes 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

UDC's system. A Parallel System, or Interconnected Generation System, is as 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 UDC's system.

The Interconnection 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 UDC's system. A description and the basic requirements for these two methods of operation are outlined below.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 5.

(a) <u>Separate System:</u>

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

Emergency or Standby generators used to supply part or all of the Interconnection Customer's load during a utility power outage must be connected to the Interconnection 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 visible and fail-safe mechanical throw over design, which will, under no circumstances, allow the Generating Facility to electrically interconnect or parallel with UDC's system. The transfer switch must always disconnect the Interconnection Customer's load from the UDC's power system prior to connecting it to the Generating Facility. Conversely, the transfer switch must also disconnect the load from the Generating Facility prior to re-connecting it back to the UDC's system. These requirements apply to both actual emergency operations as well as to testing the Generating Facility. All transfer switches and transfer schemes must be inspected and approved by the jurisdictional electrical inspection agency.

Portable Generating Facilities 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 UDC system – the generator voltage can backfeed through the UDC 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 UDC equipment.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 5.1.

(b) Parallel System:

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

Parallel generators include any type of distributed generator or Generating Facility that can electrically parallel with, or potentially backfeed the UDC system. Additionally, any Generating Facility 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 UDC system, and are classified as an interconnected Generating Facility.

The UDC has specific interconnection and contractual requirements, as outlined in these provisions that must be complied with and information that needs to be submitted for all interconnected Generating Facilities. These include a "visible open" disconnect switch meeting certain requirements to isolate the Interconnection Customer's system from the UDC's system, as well as protective relaying, metering, special rate schedules, and other safety and information requirements. The Interconnection Customer will be responsible for having the Generating Facility system protective schemes tested by a qualified testing/calibration company. UDC personnel will inspect the system and the Interconnection Customer will be required to sign an Interconnect Agreement and, as applicable, an Electric Supply/Purchase Agreement with the UDC. The UDC does not extend "blanket approval" to any specific type of Generating Facility or Generating Facility scheme since each project is site specific and needs to be reviewed on a case-by-case basis.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 5.2.

4. Other issues:

Jurisdiction:

The rates, terms or other contract provisions governing the electric power sold to a Customer are subject to the jurisdiction of the Arizona Corporation Commission (ACC). The ACC also has jurisdiction regarding the purchase of power from Customer owned Qualified Facilities (QFs) by the UDC.

The Federal Energy Regulatory Commission has jurisdiction over all interconnections with facilities that are subject to electric public utility's Open Access Transmission Tariff ("OATT") at the time the interconnection request was made.

B. Rights and Responsibilities:

After reviewing the Rights and Responsibilities included in the documentation provided from Texas, New York, New Jersey, and FERC (SGIA/SGIP) it was determined that each of the topics in this Section as referenced below were developed based on each entity's unique characteristics, which were developed after substantial input from all the parties involved. For this reason, APS recommends that this entire Section be vetted using the Working Group process.

1. Utility and Applicant:

Refer to Section B above.

2. Easements/Rights of Way:

Refer to Section B above.

3. Insurance:

Refer to Section B above.

4. **Other Issues**:

None

C. Definitions:

APS recommends adoption of a statewide set of definitions that are consistent, to the extent possible, with the definitions included in FERC's SGIA/SGIPs. For definitions to terms not used in the SGIA/SGIP, APS recommends referring to the definitions proposed in Revision 3 of the Arizona State Draft Interconnection

Requirements for Distributed Generation (submitted 11/30/99), which were developed in the previous Distributed Generation Working Group process sponsored by the ACC.

D. Interconnection Process/Procedures:

1. Procedures Addressing Both Network and Non-networked Interconnections:

Any qualified Interconnection Customer may operate its generating equipment in parallel with the UDC's radial distribution system provided the Interconnection Customer provides equipment that will:

(a) not present any hazards to UDC personnel, other customers or the public,
(b) minimize the possibility of damage to UDC's distribution and transmission systems and 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 is required).

In addition, the Interconnection Customer shall comply with the following:

(a) The generating facility shall meet all the minimum interconnection, safety, and protection requirements outlined in this manual,
(b) Interconnection Customer shall sign an Interconnect Agreement, as well as an Electric Supply /Purchase Agreement, as applicable, with UDC, and
(c) Interconnection Customer shall comply 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.

Due to relay coordination and potential backfeed problems, Small Generating Facilities will not be connected to a network system.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 4.

2. Pre-interconnection Study or Screening Criteria:

APS recommends that any Pre-interconnection Studies or Screening Criteria to be utilized to expedite the application process for Small Generating Facilities be discussed thoroughly in the ACC Working Group process.

3. Expedited Processes for Smaller Generators:

APS supports the development of an expedited application process in an ACC Working group. We believe that any such process be based upon both the size and location of the Small Generating Facility.

4. Communication Process Concerning Proposed DG Projects:

APS recommends discussing and vetting this issue during the ACC Working Group process.

5. Equipment Pre-Certification:

APS recommends discussing the issue of Equipment Pre-certification during the ACC Working Group process.

6. Utility Reporting Requirements to the Commission:

APS recommends discussing and vetting this issue during the ACC Working Group process.

7. Utility Inspections:

See Section II D below.

8. Interconnection Dispute Resolution Process:

APS recommends discussing and vetting this issue during the ACC Working Group process.

9. Disconnect From or Reconnect With the Grid Procedure:

With respect to the protection of the UDC system and the safety of its workers, it is necessary to disconnect the parallel generator when trouble occurs. This is to:

(i) ensure if a fault on the UDC system persists, the fault current supplied by the Interconnection Customer's Generating Facility is interrupted;
(ii) prevent the possibility of reclosing into an out-of-synch isolated system composed of the UDC distribution system, or a section thereof, and the Interconnection Customer's Generating Facility; and
(iii)prevent reclosing into the Interconnection Customer's Generating Facility system that may be out of synchronization or stalled.

The Parties shall cooperate with each other to restore the Small Generating Facility, Interconnection Facilities, and the UDC's Distribution System to their

normal operating state as soon as reasonably practicable following a temporary disconnection.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 8.

10. Other Issues:

None

E. Application Process and Document Requirements:

After reviewing the application process and document requirements contained in the Draft Interconnection Standards from the last set of Distributed Generation Workshops as well as documentation provided from Texas, New York, New Jersey, and FERC (SGIA/SGIP) there was no specific language that APS can clearly recommend. APS recommends that the Application Process and Documentation Requirements be vetted using the Working Group Process. APS further recommends that any recommendations determined through the ACC Working Group process will be consistent with the requirements specified in the SGIA/SGIP.

1. Time Periods for Processing Applications:

See Section E above

2. Steps in the Process:

See Section E above

3. Documentation Requirements:

See Section E above

4. Designation of Utility Contact Persons:

The UDC shall designate an employee or office from which information on the application process can be obtained through informal requests from the Interconnection customer presenting a proposed project for a specific site. The name, telephone number, and e-mail address of such contact employee or office shall be made available on the UDC's web site.

5. Other Issues:

None

II. Interconnection Technical and Operational Requirements

A. Categories of Equipment:

None

B. Design Considerations/Protective Equipment Requirements:

1. Design Considerations:

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

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 7.

(a) <u>Synchronous Units:</u>

Synchronous generators are generally capable of supplying sustained current for faults on the UDC system. These units can also supply isolated Utility load providing the load is within the units' output capability.

Reclosing of the UDC onto synchronous units must be blocked to prevent out-of-synch paralleling and must also be prevented from energizing a de-energized utility line. Automatic reclosing by UDC is time-delayed to allow for automatic Interconnection Customer Generating Facility separation prior to UDC circuit re-energization.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 7.1.

(b) <u>Induction Units:</u>

Induction Generating Facilities 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 Generating Facilities are therefore normally not capable of supplying sustained fault

current into faults on the UDC system. Such units are generally not capable of supplying isolated load when separated from the UDC system; however, it is possible for an induction Generating Facility to become self-excited if a sufficient amount of capacitance exists at its output terminals. Under conditions of self-excitation, an induction Generating Facility 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 UDC and its other customers must be protected from out-of-phase closing and over-voltages that can occur whenever an induction Generating Facility becomes self-excited. Induction units must therefore be designed to automatically separate from the UDC's system upon loss of UDC voltage and prior to reclosing of the UDC's feeder.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 7.2.

(c) <u>Static Inverters:</u>

Static inverters convert DC power to AC by means of electronic switching. Switching can be controlled by the AC voltage of the UDC's supply system (line-commutated) or by internal electronic circuitry (forced-commutated).

Line-commutated inverters are generally not capable of operating independently of the UDC'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 UDC must be specifically designed for that purpose, i.e. it must be designed to accommodate parallel interfacing and operation.

Reclosing of the UDC onto inverter units must be blocked to prevent out-of-synch closing and to prevent the energizing of a de-energized UDC line.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 7.3.

2. Protective Equipment Requirements (Interconnection Technical Requirements):

The requirements and specifications outlined in this section are applicable to all classes of distributed generation, unless otherwise specified. The minimum protection and safety devices and other requirements imposed in the following sections are intended to provide protection for the UDC system and its other customers. They are not imposed to provide protection for the Interconnection Customer's generation equipment; this is the sole responsibility of the Interconnection Customer. These requirements are in addition to requirements outlined in other sections of these provisions.

The protection requirements are minimal for smaller installations, but increase as the size of the Interconnection Customer's generation increases. Small installations usually ensure that the Generating Facility is small compared with the magnitude of any load with which it might be isolated. Thus, for any fault on the UDC system, UDC protective devices will operate and normally isolate the Generating Facility with a large amount of load, causing voltage collapse and automatic shutdown of the Generating Facility. 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 UDC circuit. In instances where the UDC system arrangement is such that it is possible that the Generating Facilities will not always be isolated with comparatively large amounts of load, additional protection and Generating Facility shutdown schemes are required.

The Interconnection Customer is solely responsible for the protection of his equipment from automatic reclosing by the UDC. The UDC normally applies automatic reclosing to overhead distribution circuits. When the UDC source breaker trips, the Interconnection Customer must ensure that his Generating Facility is disconnected from the UDC circuit prior to automatic reclosure by the UDC (the automatic reclosing on UDC distribution feeders is normally delayed by at least 2 seconds). Automatic reclosing out-of-synch with the Interconnection Customer's Generating Facility may cause severe damage to Interconnection Customer equipment and could also pose a serious hazard to Interconnection Customer or UDC personnel.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 8.

(c) General Technical Requirements:

(i) Interconnection Customer is responsible for obtaining and maintaining all required permits and inspections indicating that the Interconnection

Customer's Generating Facility complies with all applicable codes, ordinances and statutes relating to safety and construction.

(ii) Multiple Generating Facility connections on the same UDC service are permitted subject to UDC approval; however, a single Disconnect Switch for the facility will be required (normally located at the service entrance section).

(iii) In the event that a Generating Facility, or aggregate of Generating Facilities, are of sufficient size to carry the entire (minimum) load of the UDC's distribution feeder, or if a Generating Facility's 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 Interconnection Customer's expense. If a transfer trip is required, a communication channel and telemetering may also be required. In certain instances, a dedicated UDC feeder may be required.

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

(v) In the event that the UDC is required to install electric meter(s) to record the output of the Generating Facility, Interconnection Customer shall ensure that the design is such that the meter(s) are located on the UDC-side of the Generating Facility breaker on a normally energized bus. Electronic meters are not designed to be de-energized for any length of time.

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

(vii) The Interconnection Customer is responsible for the design, installation, operation and maintenance of all equipment on the Interconnection Customer's side of the Point of Interconnection. It is also the Interconnection Customer's responsibility to submit specifications and detailed plans as specified in this manual for the installation to the UDC for review and written approval prior to their purchase and installation. Written approval by UDC does not indicate acceptance by other authorities.

(viii) UDC will not install or maintain any lines or equipment on an Interconnection Customer's side of the Point of Interconnection, except it may install its meter and some research equipment. Only authorized UDC employees (with credentials to identify their company affiliation) may make and energize the service connection between the UDC system and the Interconnection Customer's service entrance conductors.

(ix)Normally, the interconnection will be arranged to accept only one type of standard service at one Point of Interconnection. If an Interconnection Customer's Generating Facility requires a special type of service, or if sales to UDC 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.

(x) The minimum protective and safety devices (relays, circuit breakers, disconnect switches, etc.) specified in these provisions must be installed and placed into service before allowing parallel operation of the Interconnection Customer's Generation Facilities with the UDC's system. The purpose of these devices is to isolate the Interconnection Customer's Generating Facility equipment from the UDC's system whenever faults or disturbances occur and for maintenance purposes. Modifications to the UDC electrical system configuration or protective equipment may also be required at the expense of the Interconnection Customer in order to accommodate parallel generation.

(xi)The UDC will not assume any responsibility for the protection of the Interconnection Customer's Generating Facility, or of any other portion of the Interconnection Customer's electrical equipment. The Interconnection Customer is fully and solely responsible for protecting his equipment in a manner to prevent any faults or other disturbances from damaging the Interconnection Customer's equipment.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Sections 8.1 as well as the Arizona Public Service Company's Interconnection Requirements for Distributed Generation.

(d) Disconnect Switch:

The Interconnection Customer shall install and maintain a visible open, manually- and gang-operated load-break disconnect switch ("Disconnect Switch") capable of being locked in a visibly "open" position by a standard UDC padlock that will completely isolate the Interconnection Customer's Generating Facility from the UDC's system.

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 UDC personnel on a 24-hour basis. The UDC shall have the right to lock open the Disconnect Switch without notice to the Interconnection Customer when interconnected operation of the Customer's generating facility with the UDC's system could adversely affect UDC's 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 Interconnection Customer's electrical service entrance section; however, it may be located in the immediate vicinity of the Generating Facility, subject to UDC approval.

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

In cases where the Disconnect Switch will be installed on a line at a voltage above 500V, the UDC has 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 UDC may require the Interconnection 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 UDC will work with the Interconnection Customer to determine the best option and ensure that the safety requirements are met.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 8.2.

(e) Dedicated Transformer:

Interconnection Customer Generating Facilities with a combined total rating of over 10 kW, as measured at the service entrance, must be isolated from other customers fed off the same UDC transformer by a dedicated power transformer connecting to the UDC distribution feeder. The purpose of the dedicated transformer is to ensure that the Generating Facility cannot become isolated at the secondary voltage level with a small amount of other-customer load. It also helps to confine any voltage fluctuation or harmonics produced by the Generating Facility to the Interconnection Customer's own system. The UDC will specify the transformer winding connections and any grounding requirements.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 8.3.

(f) Labeling Requirements:

(i) **General Requirements:** The Interconnection Customer shall conform to the NEC for labeling of generation equipment, switches, breakers, etc. The UDC will assume responsibility for labeling any UDC equipment.

(ii) **Disconnect Switch**: The Interconnection shall label the Disconnect Switch "Generator Utility Disconnect Switch" (or "Photovoltaic Inverter, Wind Turbine, etc, Utility Disconnect Switch", as the case may be) by means of a permanently attached placard with clearly visible and permanent letters.

(iii)**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 designed by groups.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 8.6.

(g) Protective Requirements:

(i) General Requirements:

a The Interconnection Customer shall be solely responsible for properly protecting and synchronizing his generator(s) with the UDC's system

b Interconnection Customer facility's shall include an automatic interrupting device 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.

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

d For Generating Facilities classes II and above (>50 kW), utilizing discreet relays, separate and independent voltage and frequency relays and associated trip paths 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 on microprocessor based devices may be used provided that the required functionality described herein in demonstrated.

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

- Protective relay failure will not only alarm but will also trip the Generating Facility breaker/contactor.

- If a relay failure alarms, but does not trip the Generating Facility breaker, then additional relaying which meets the requirements stated herein for each class must be provided.

f With the addition of generation at an Interconnection Customer's 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 Interconnection Customer's grounding grid to keep the step and touch potentials at a safe level

g The Interconnection Customer shall ensure that the Generating Facility protective relaying and controls are adequately protected from electrical surges that may result from lightning, UDC switching or electrical faults.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 8.7.1.

(ii) Generating Facility Class Protective Requirements:

a Class I (Single or Three Phase: 50 kW or less)

- The minimum protection required is an under-voltage contactor.
- For all synchronous Generating Facilities and forced commutated inverters, a synchronizing scheme, either manual with synch check relay, or an automatic synchronizer is required.

b Class II (Three Phase: 51-300 kW)

- Relays for overvoltage, undervoltage, overfrequency, and underfrequency are required.
- For all synchronous Generating Facilities and forced commutated inverters, either a manual or automatic synchronizing scheme is required.
- For installations interconnected to the UDC through a transformer with connections that will not supply current to a ground fault on the UDC system, a ground fault detector may be necessary. The UDC will advise Interconnection Customer of any such requirements after a preliminary review of the interconnection Customer's proposed installation.

- Other equipment such as supervisory control and alarms, telemetering and associated communications channels may be necessary. This is especially the case when (a) the Generating Facility, or an aggregate of Generating Facilities is large relative to the minimum load on a feeder or sectionalized portion of the feeder, or (b) the Generating Facility is remotely controlled by, or dispatched by the UDC. The UDC will advise the Interconnection Customer of any communications requirements after a preliminary review of the proposed installation.

c Class III (Three Phase: 301-5,000 kW)

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

- Relays for overvoltage, undervoltage, overfrequency, and underfrequency are required.

- For all synchronous Generating Facilities and forced commutated inverters, either a manual or automatic synchronizing scheme is required.

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

- Other equipment such as supervisory control and alarms, telemetering and associated communications channels may be necessary. This is especially the case when (a) the Generating Facility, or an aggregate of Generating Facilities is large relative to the minimum load on a feeder or sectionalized portion of the feeder, or (b) the Generating Facility is remotely controlled by, or dispatched by the UDC. The UDC will advise Interconnection Customer of any communications requirements after a preliminary review of the proposed installation.

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

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

- Protection for overvoltage, undervoltage, overfrequency, and underfrequency are required.

- For all synchronous Generating Facilities and forced commutated inverters, either a manual or automatic synchronizing scheme is required.

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

- The following relays are also required:

  - Voltage-controlled time overcurrent relays, one per phase
  - Negative sequence time overcurrent relay
  - Overexcitation relay
  - Loss of excitation relay

- Other equipment such as supervisory control and alarms, telemetering and associated communications channels may be necessary. This is especially the case when (a) the Generating Facility, or an aggregate of Generating Facilities is large relative to the minimum load on a feeder or sectionalized portion of the feeder, or (b) the Generating Facility is remotely controlled by, or dispatched by the UDC. The UDC will advise Interconnection 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 Generating Facility/ Line Commutated Inverter	Synchronous Generating Facility/ Forced Commutated Inverter
Class I 50 kW or less	Undervoltage contactor	Undervoltage contactor Synchronizing
Class II 51 to 300 kW	Overvoltage, Undervoltage Overfrequency, Underfrequency	Overvoltage, Undervoltage Overfrequency, Underfrequency Synchronizing
Class III 301 to 5,000 kW	Overvoltage, Undervoltage Overfrequency, Underfrequency	Overvoltage, Undervoltage Overfrequency, Underfrequency Synchronizing
Class IV Greater than 5,000 kW	No induction generators of this size anticipated	Overvoltage, Undervoltage Overfrequency, Underfrequency Synchronizing Ground Time Overcurrent Ground Instantaneous Overcurrent Voltage-controlled Time Overcurrent Loss of Excitation Overexcitation Negative Sequence Time Overcurrent

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 8.7.2.

(iii)Relay Settings:

Voltage and frequency relays needed for minimum interface protection for all classes will have setting limits as specified below.

a. Undervoltage relays will operate at no less than 80% of the nominal voltage level (96 volts on a 120V base) and will have a maximum time delay of 1.0 seconds.

b. Overvoltage relays will operate at no greater than 120% of nominal voltage (144 volts on a 120V base) and will have a maximum time delay of 1.0 seconds.

c. Overfrequency relays will operate at no greater than 62 Hz and will have a maximum time delay of 1.0 seconds.

d. Underfrequency relays will operate at no less than 58 Hz and have a maximum time delay of 1.0 seconds.

Additional settings for Class IV installations and/or any other relays that may be required due to unusual circumstances will be handled on an individual basis.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 8.7.3.

C. Operational Requirements

In order to minimize interference on the utility system the Interconnection Customer should ensure that the electrical characteristics of its load and Generating Facility equipment meet, as a minimum, the specifications promulgated in the Institute of Electrical and Electronic Engineers (IEEE) Standard 519-1992.

This language was taken from Arizona Public Service Company's Interconnection Requirements for Distributed Generation at Section 8.4.

1. Power Factor:

The power factor of the Interconnection Customer's Generating Facility shall not be less that ninety percent (90%) lagging, but shall not be leading, unless agreed to by UDC.

This language was taken from Arizona Public Service Company's Interconnection Requirements for Distributed Generation at Section 8.4.1.

2. Current Imbalance:

The current imbalance for a three-phase system as measured at the Interconnection Customer's service entrance section shall not be greater than ten percent (10%) at any time.

This language was taken from Arizona Public Service Company's Interconnection Requirements for Distributed Generation at Section 8.4.2.

3. Harmonics:

The electrical output of the Interconnection Customer's Generating Facility shall not contain harmonic content which may cause disturbances on or damage to UDC's electrical system, or other customer's systems, such as but not limited to computer, telephone, communication and other sensitive electronic or control systems.

This language was taken from Arizona Public Service Company's Interconnection Requirements for Distributed Generation at Section 8.4.3.

4. Power Fluctuations:

The Interconnection Customer must exercise reasonable care to assure that the electrical characteristics of its load and Generating Facility equipment, such as 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.

This language was taken from Arizona Public Service Company's Interconnection Requirements for Distributed Generation at Section 8.4.4.

5. Voltage Flicker:

If the Interconnection Customer utilizes the UDC's system to facilitate start-up of its Generating Facility, the voltage flicker level shall not exceed UDC standards.

This language was taken from Arizona Public Service Company's Interconnection Requirements for Distributed Generation at Section 8.4.5.

6. Voltage levels:

Interconnection Customer generating equipment must deliver at the Point of Interconnection, 60 Hertz, either single or three-phase power at one standard voltage. (normally 12,470; 2400/4160; 277/480; 120/240 or 120/208 volts as may be selected by the Interconnection Customer subject to availability at the premises). Interconnections at other voltage levels will be handled on a case-by-case basis.

This language was taken from Arizona Public Service Company's Interconnection Requirements for Distributed Generation at Section 8.4.6.

7. Network & Non-network items:

Due to relay coordination and potential backfeed problems, APS recommends the prohibition of connecting Generating Facilities to a network system.

D. Inspection and Start-up Testing:

APS recommends that the specifics involving Inspection and Start-up testing be vetted using the ACC Working Group Process. This will allow the ACC Working

Group to properly incorporate the Inspection and Start-up requirements of any pre-certified equipment approval process utilized by the Working Group.

E. Testing and Commissioning:

a. Following UDC approval of the Interconnection Customer's generating facility and associated minimum interconnection requirements, the Interconnection Customer shall, at a minimum, have all specified interface equipment, shutdown and associated protective devices 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 must include on-site bench testing of pickup and timing characteristics of the relays. Functional testing must demonstrate that each (minimum) protective relay 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 will open. A trip timing test (simulated loss of voltage) will suffice for static inverters rated 50kW or less.

b. The Interconnection Customer shall provide UDC with a copy of calibration and functional test results. Interconnection Customer must also notify UDC at least five (5) working days in advance that such tests are to be performed and allow UDC personnel to witness such tests.

c. The Interconnection Customer will be required to have a signed Interconnect Agreement with the UDC, and will need to provide UDC with a copy of the insurance certificate, as applicable, prior to electrically paralleling the generating facility with the UDC's system.

d. The Interconnection Customer will not commence interconnected operation of its generating facility until the installation has been inspected by an authorized UDC representative and final written approval is received from the UDC to commence interconnected operation, which approval shall not be unreasonably withheld. The Interconnection Customer shall give the UDC at least five (5) working days prior to notice of when initial startup is to begin. The UDC will have the right to have a representative present during initial energizing and testing of the Interconnection Customer's system.

e. The Interconnection Customer shall have all protective devices tested by a competent testing firm at the time of installation, prior to initial interconnection, and at intervals not to exceed four (4) years by qualified test personnel. The Interconnection Customer shall (i) notify the UDC as to when such tests are to be performed at least five (5) working days prior to such tests and allow UDC personnel to witness the test, and (ii) provide the UDC with a certified copy of the test results.

f The Interconnection Customer will allow the UDC and its authorized agents access to the protective relaying and control facilities to conduct whatever startup or periodic tests the UDC deems necessary. The UDC will provide the Interconnection Customer with advance notice of such tests, so that the Interconnection Customer's representatives may be in attendance when such tests are performed.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 10.

F. Meter Installations:

The requirements of this section are applicable to Interconnection Customers that either purchase power from, or sell or deliver energy to the UDC (QF Generating Facilities as defined under PURPA).

The Interconnection Customer must provide and install at Interconnection Customer's expense, and in accordance with UDC service standards, meter sockets and metering cabinets in a suitable location.

The UDC will furnish, own, install and maintain all meters that register the sales of power to, and the purchase of energy from the Interconnection Customer. The responsibility for the costs of providing and maintaining the required meters will be outlined in the applicable rate tariff, or specified in the Electric Supply/ Purchase Agreement.

The requirements for electric metering are specified in the UDC document titled "UDC Electric Service Requirements". Also, depending on the specific application, one of the following UDC documents will outline applicable rates and requirements for cogeneration /small power production facilities rated at 100 kW or less. Facilities with a higher capacity will be considered on an individual basis.

This language was taken from Arizona Public Service Company's Interconnection Requirements for Distributed Generation at Section 9.

G. Maintenance Requirements:

1. The Interconnection 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.

2. The Interconnection Customer shall protect, operate and maintain the Generating Facility in accordance with those practices and methods, as they

are changed from time-to-time, which are commonly used in prudent engineering and electric utility operations and shall operate and maintain the Generating Facility lawfully in a safe manner and non-hazardous condition.

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

4. The UDC will be allowed to install on Interconnection Customer's premises any instrumentation equipment for research purposes. Such equipment shall be owned, furnished, installed and maintained by the UDC.

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

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

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

7. Upon termination of the Interconnect Agreement, the Interconnection Customer shall be responsible for ensuring that the Disconnect Switch is immediately opened, and that the electric conductors connecting the Interconnection Customer's Generating Facilities to the Disconnect Switch are

lifted and permanently removed, so as to preclude any possibility of interconnected operation in the future. The UDC reserves the right to inspect the Interconnection Customer's facility to verify that the Generating Facility is permanently disconnected.

This language was taken from Revision 3 of the Arizona State Draft Interconnection Requirements for Distributed Generation (submitted 11/30/99), at Section 11.

H. Other Issues:

None

III. Other Considerations

A. **Net Metering:**

It is APS' understanding that the purpose of this portion of the ACC Working Group is to address interconnection standards and produce a Staff report on interconnection by the end of the year. While it is agreed that the concept of Net Metering is an important issue we recommend that the concept of net-metering and net-billing be discussed in the rate design portion of the Working Group process. For this reason, APS recommends that the Working Group address Net Metering during the rate design portion of the Working Group discussions.

The concept of Net Metering and Net Billing is often incorrectly viewed as being interchangeable within the industry. For clarity purposes, APS has included a short discussion on both Net Metering and Net Billing below:

1. **Net Metering Defined**

The concept of net metering is typically described as "allowing the meter to run backwards." In addition to receiving full credit for displacing its own load, net metering gives Small Generating Facility customers credit for all energy supplied to the distribution grid at the customer's applicable rate (using unbundled elements of the customer's standard offer rate). When a Small Generating Facility produces more energy than the load it is supporting, excess energy backfeeds onto the UDC's distribution grid. Any excess energy produced by the Small Generating Facility is then subtracted from the total kWh purchased by the customer allowing the meter to "run backwards."

All energy generated by the Small Generating Facility customer is, in effect, priced at the UDC's applicable rate (using unbundled elements of the customer's standard offer rate). Currently, standard offer rates are designed to recover investment and expenses associated with the Utility's generation, transmission, and distribution systems. Instead of giving credit to the

distributed generation customer for generation, net metering gives the Small Generating Facility customer additional credit for transmission and distribution. This subsidizes the distributed generation and shifts additional transmission and distribution costs to other UDC customers as well as, items that are intended to be non-by passable such as system benefit costs, EPS surcharges, PSA surcharges, etc.

2. **Net Billing Defined**

A concept of net billing requires the installation of a bi-directional meter that has two separate metering registers to record sales to the Small Generating Facility Customer and purchases from the Small Generating Facility Customer. The Small Generating Facility Customer is charged the appropriate retail rate under the applicable tariff for their energy usage (sales to the customer). The Utility purchases excess energy from the customer at the current buy-back rate in accordance with the provisions of the applicable partial requirements tariff. Purchases from the Small Generating Facility customer only occur when the Small Generating Facility customer's generation exceeds their load at any given instant.

B. Other Issues:

In addition, APS would also like to discuss the treatment of Small Generating Facilities when there is a change in ownership (e.g. the owners of a 5 kW solar rooftop residential unit sell their house).