1.0 PURPOSE

The purpose of this document is to define policy and provide engineering guidelines for the AP operating companies (Monongahela Power Company, The Potomac Edison Company, and West Penn Power Company) hereinafter referred to collectively as “AP” or “the Company” concerning interconnection facilities built for the main purpose of providing service to small electric generators, PURPA qualifying facility generator installations, or net-metering generating facilities, hereinafter referred to as “generator” at the distribution system voltage level (may be 34.5 kV and below).

2.0 SCOPE

This document shall apply to generator interconnections connected at the distribution system voltage level with an aggregate size of 2 MW, nominal or less at the point of interconnection regardless of intent to sell power beyond the point of interconnection. These requirements do not apply to automatic transfer schemes in which load is transferred between the AP and the generator in a momentary make-before-break operation provided the duration of synchronizing/paralleling the sources is less than 100 ms, except Paragraph 3 – Voltage Fluctuation requirements in the SERVICE QUALITY section 6.0 shall apply. These requirements do not apply to emergency or standby generation automatic transfer schemes with non-paralleling (break-before-make) operation.

NOTE 1
This document is intended to comply with IEEE 1547 – Standard for Interconnecting Distributed Resources with Electric Power Systems, PJM Small Generator Interconnection “Applicable Technical Requirements and Standards”, and the National Electrical Code, Article 690 – Solar Photovoltaic Systems, Article 692 – Fuel Cell Systems and Article 705 – Interconnected Electric Power Production Sources. For further information, please refer to these documents.

NOTE 2
See Section 19, S.I. 36 for requirements concerning interconnection facilities with generator installations greater than 2 MW at the distribution system voltage level.

See Section 19, S.I. 36 for requirements concerning interconnection facilities with generator installations at the subtransmission and transmission system voltage level.
3.0 GENERAL

Interconnection of generators and distributed generation requires many technical and safety aspects to be considered prior to the connection of the equipment. These technical and safety aspects shall be considered for all modes of facility operation including normal, abnormal, maintenance, and contingent operations. Abnormal conditions arise on the AP circuits that require a response from the interconnected generator. This response contributes to the safety of utility maintenance personnel and the general public, as well as the avoidance of damage to connected equipment, including the generator(s). **Personnel and public safety shall not be compromised.** AP operations shall not be disrupted nor shall AP equipment be harmed or damaged with the interconnection or operation of generators and distributed generation. Neighboring customers shall not have their service quality, operations or equipment adversely affected by the connection or operation of generators or distributed generation.

Listed below is the priority for evaluating technical and safety aspects concerning the connection of generators or distributed generation:

1. Safety
   - Personnel Protection
   - Public Safety

2. Operation / Service Quality
   - AP Operation and Equipment
   - Neighboring Customer Service Quality, Operation and Equipment

3. Generator Facility Considerations
   - Operation, Equipment and Service Quality
   - Ability for the generator/distributed generation to offset load or produce revenue

Beyond these safety, operation, and service quality requirements, generators distributed generation shall be permitted to operate their facilities as they see fit to offset load or produce revenue. Sale of energy produced and any transmission access shall be contracted with PJM. AP shall have no obligation to purchase excess energy produced except as provided in existing Tariffs such as net metering. Generators and distributed generation shall be permitted to generate inadvertent energy into Allegheny Power, provided no personal safety, public safety, operational or service quality issues exist.

In some cases, AP will need to provide a line extension to generator facilities. Customer financing for AP supplied facilities may be required as described in Company’s line extension policy and filed tariffs.
The specific voltage and connection requirements are dependant on many factors including customer load characteristics and the capacity and configuration of the AP distribution system at the point of service. AP planning personnel will determine these requirements.

### 4.0 SAFETY REQUIREMENTS

1. The generating facility shall not energize AP circuit when AP’s circuit is de-energized for any reason.
2. Upon de-energization of AP circuit by AP, generation must be automatically disconnected from AP and remain disconnected for a period of not less than two minutes after re-energizing of AP circuit. Automatic disconnection shall occur within a maximum of 2 seconds of de-energizing AP circuit so an unintentional island is not formed. Reference Table 1 in *Response to Abnormal Voltage*.
3. AP will automatically reclose AP circuits after tripping operation(s) occur. Generation facility shall not affect automatic reclosing of AP circuit.
4. All generators must cease parallel operation upon notification by AP personnel if such operation is determined to be unsafe, is deleterious to the supply of service to other customers, or interferes with system operation, service restoration, or maintenance.
5. The AP distribution system is an effectively grounded wye-connected system. The grounding scheme of the generator interconnection shall not cause overvoltages that exceed the rating of AP connected equipment and shall not disrupt the coordination of the ground fault protection on the AP circuit.
6. Transfer-trip schemes shall not be employed on the AP distribution system.
7. Generator’s circuit interrupting devices shall have sufficient interrupting capacity for all faults that might exist at the point of common coupling. Maximum available RMS symmetrical fault current at the generator’s location from AP system is available by AP Planning personnel.
8. The generator facility shall have a readily accessible, lockable, load-break, visible-break isolation device located at the point of common coupling accessible without notice by AP personnel.
9. Generator’s electrical system installation shall comply with current edition of the National Electrical Code at the time of acceptance testing.

### 5.0 RELIABLE OPERATIONS

1. **System Design, Installation and Maintenance**: The generator assumes sole responsibility to design, install and maintain their system to comply with all technical requirements and properly operate on the AP system.
2. **Output Monitoring**: Each generating unit of 250 kVA or more or aggregate of 250 kVA or more at a single point of common coupling shall have provisions for monitoring its connection status, real power output, reactive power output, and voltage at the point of interconnection.

3. **Protective System**: The generator’s protective system is responsible to protect against faults or disturbances on the AP system. The generator is also responsible for ensuring that the protective system and the associated devices are maintained in reliable operating condition. AP reserves the right to inspect and test all protective equipment.

4. **Responsibility**: The generator is solely responsible for the installation, operation and maintenance of any equipment used to interconnect with AP and is liable for any claims, demands, suits, actions and judgments, and all costs expenses, pecuniary or other loss which may arise directly or indirectly from any act or omission of the generator owner, its agents, servants or employees, particularly cause by improper installation, improper operation, or defective equipment.

### 6.0 SERVICE QUALITY

1. **General**: All voltage and frequency parameters specified in these requirements shall be met at the point of common coupling (PCC), unless otherwise stated.

2. **Voltage Regulation**: The generator shall not actively regulate the voltage at the PCC. The generator installation shall not cause the AP service voltage at other customers to go outside the requirements of ANSI C84.1-1995 Range A.

3. **Voltage Fluctuation**: The generator(s) shall synchronize and parallel and/or transfer load with AP circuit without causing a voltage fluctuation at the point of common coupling greater than +/- 5% of the prevailing voltage level. Generating equipment shall also meet the voltage fluctuation and flicker requirements of IEEE 1453 – *Recommended Practice for Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems* during normal, paralleling or load transfer operation. Engineering Manual Section 46, SI 02 on Flicker provides further application information on voltage fluctuation and flicker.

4. **Harmonics**: Generators or generating equipment shall not inject non-sinusoidal current nor adversely affect voltage, frequency or wave shape of power supplied at the point of common coupling. Generators and generating equipment shall meet both the voltage and current harmonic limit requirements of IEEE 519 – *Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*. Engineering Manual Section 46, SI 01 on Harmonics provides further application information on voltage and current harmonics and limits.
5. **Response to Abnormal Voltage:** The protection functions of the interconnection system shall detect the effective (rms) or fundamental frequency value of each phase-to-neutral phase voltage. When any voltage is in a range given in Table 1, the generator shall cease to energize AP within the clearing time as indicated. Clearing time is the time between the start of the abnormal condition and the generating equipment ceasing to energize AP circuit. For generators less than or equal to 30 kW in peak capacity, the voltage set points and clearing times shall be either fixed or field adjustable. For generators greater than 30 kW, the voltage points shall be field adjustable.

The voltages shall be detected at the PCC. The voltage detection shall be permitted at the point of generator connection when any of the following conditions exist:

a. The aggregate capacity of the generating system connected to a single PCC is less than or equal to 30 kW.
b. The interconnection equipment is pre-certified to pass a non-islanding test for the system to which it is to be connected.
c. The aggregate generating capacity is less than 50% of the total distribution circuit, minimum annual integrated electrical demand for a 15-minute time period, and export of real or reactive power by the generating facility to AP circuit is not permitted.

6. **Response to Abnormal Frequency:** When the system is in a range given in Table 2, the generating equipment shall cease to energize the AP circuit with the clearing time as indicated. Clearing time is the time between the start of the abnormal condition and the generating equipment ceasing to energize the AP circuit. For generators greater than 30 kW, the frequency set points shall be field adjustable. Adjustable under-frequency trip settings shall be coordinated with AP Planning as necessary.

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**Table 1—Interconnection system response to abnormal voltages**

<table>
<thead>
<tr>
<th>Voltage range (% of base voltage)</th>
<th>Clearing time(s)</th>
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<tbody>
<tr>
<td>V &lt; 50</td>
<td>0.16</td>
</tr>
<tr>
<td>50 ≤ V &lt; 88</td>
<td>2.00</td>
</tr>
<tr>
<td>110 &lt; V &lt; 120</td>
<td>1.00</td>
</tr>
<tr>
<td>V ≥ 120</td>
<td>0.16</td>
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</tbody>
</table>

*aBase voltages are the nominal system voltages stated in ANSI C84.1-1995, Table 1.
*bDR ≤ 30 kW, maximum clearing times; DR > 30 kW, default clearing times.

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**Source:** Distribution Engineering
7. **Reconnection to AP Circuit:** After a voltage or frequency disturbance, no reconnection of the generators shall take place until the voltage at the PCC is within Range B of ANSI C84.1-1995, Table 1, and frequency range of 59.3 Hz to 60.5 Hz. The interconnection system shall include a delay of not less than two minutes to delay reconnection after the steady state voltage and frequency are restored to the ranges identified above.

7.0 **SPECIFIC REQUIREMENTS**

1. **PJM Small Generator Interconnection:** Figure 1 shows the “Applicable Technical Requirements and Standards” that apply to all new primary distribution generator interconnections, intending to sell energy to PJM, with an aggregate size of 2 MW or less at the point of common coupling (Point of Interconnection - PJM). The interconnection requirements set forth in this figure are specified by PJM.

   a. The point of common coupling (PCC) is at primary voltage.
   b. The generator shall be a three-phase generator.
   c. The interface transformer shall be grounded wye on the utility (or primary) side.
   d. Interconnection relaying shall operate the GEN CB as shown on Figure 1 and shall consist of the following:
      i. 27 Under Voltage Relay
      ii. 59 Over Voltage (phase to ground) Relay
      iii. 59G Over Voltage (Zero-sequence) Relay
      iv. 81 Over and Under Frequency Relay
      v. 25 Synchronism Check Relay
      vi. 67 AC Directional Overcurrent and/or 32 Directional Power (reverse power)

*Source: Distribution Engineering*
<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
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<tr>
<td>05/11/05</td>
<td><strong>e.</strong> The visible/lockable, load-break, disconnecting means and fault-interrupting device at the PCC shall be accessible by Allegheny Power personnel to operate, without notice, during system emergencies and outage restoration activities. A high voltage, power circuit breaker and disconnect switch shall be permitted to act as the visible/lockable, load-break disconnecting means and fault interrupting device provided the requirements of Part g. – Circuit Breaker and Disconnect Switch Specifications are met.**</td>
</tr>
<tr>
<td>10/05/06</td>
<td><strong>f.</strong> Should the customer desire to operate their generator or distributed generation to supply their local load during emergency periods and utility outages as an island, the customer shall install a circuit breaker as the visible/lockable, load-break, disconnecting means and fault interrupting device. The requirements of Part g. – Circuit Breaker and Disconnect Switch Specifications shall apply.**</td>
</tr>
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<td><strong>g.</strong> Circuit Breaker and Disconnect Switch Specifications:</td>
</tr>
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<td></td>
<td>i. Circuit breaker shall be suitable for the application such as available fault current, BIL, load current, and etc. as determined by ANSI C37 standards.</td>
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<td>ii. Circuit breaker tripping circuit shall be wired with utility grade interconnecting relaying.</td>
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<tr>
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<td>1. Interconnecting relaying shall consist of the following:</td>
</tr>
<tr>
<td></td>
<td>a. 27 Under Voltage Relay</td>
</tr>
<tr>
<td></td>
<td>b. 59 Over Voltage (phase to ground) Relay</td>
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<tr>
<td></td>
<td>c. 59G Over Voltage (zero-sequence) Relay</td>
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<td></td>
<td>d. 81 Over and Under Frequency Relay</td>
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<td>e. 25 Synchronism Check Relay</td>
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<td></td>
<td>f. 67 AC Directional Overcurrent and/or 32 Directional Power (reverse power)</td>
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<tr>
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<td>iii. This breaker shall also have overcurrent relaying suitable for the particular application.</td>
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<td>1. Overcurrent relaying shall consist of the following:</td>
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<td>a. 50/51 instantaneous overcurrent / time overcurrent relay (phase current - 3)</td>
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<tr>
<td></td>
<td>b. 50/51G instantaneous overcurrent / time overcurrent relay (ground fault)</td>
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<td>iv. Potential transformers (3) shall be on the line side of the breaker.</td>
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<td>v. The breaker shall have local tripping capability such as a pushbutton or other means clearly identified for Allegheny personnel.</td>
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<td>vi. The disconnect switch shall be used to provide a visible opening in the high voltage circuit. The disconnect switch shall be permitted to be non-load break, hook stick operated.</td>
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<td><strong>h.</strong> Customer Owned Metering shall be required as shown in Figure 1. All metering CTs and PTs shall be metering grade.</td>
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<td></td>
<td><strong>i.</strong> Retail Meter shall be metering package specified and installed by Allegheny Power as appropriate for the load and particular rate schedule.</td>
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2. **Secondary Connected Generator**: Figure 2 shows the “Applicable Technical Requirements and Standards” that apply to all new secondary distribution generator interconnections with an aggregate size of 2 MW or less at the point of common coupling. These interconnection requirements set forth in this figure are intended for customers to offset load or for net metering and are not intended to sell energy to PJM.

   a. The point of common coupling (PCC) is at secondary voltage.
   b. The generator shall be a three-phase or a single-phase generator.
   c. The interface transformer shall be owned and installed by Allegheny Power. It shall be single phase or grounded wye on the utility (or primary) side. The interface transformer shall be single phase (120/240 V.) or grounded wye (480Y/277 V. or 208Y/120 V.) on the secondary side.
   d. Interconnection relaying shall operate the generator circuit breaker (GEN CB) as shown on Figure 2 and shall consist of the following:
      i. 27 Under Voltage Relay
      ii. 59 Over Voltage (phase to ground) Relay
      iii. 59G Over Voltage (zero-sequence) Relay
      iv. 81 Over and Under Frequency Relay
      v. 25 Synchronism Check Relay
      vi. 67 AC Directional Overcurrent and/or 32 Directional Power (reverse power)
   e. The visible/lockable, load-break, disconnecting means and fault-interrupting device at the PCC shall be accessible by Allegheny Power personnel to operate, without notice, during system emergencies and outage restoration activities. A power circuit breaker with remote tripping capabilities shall be permitted to act as the visible/lockable, load-break disconnecting means and fault-interrupting device provided the requirements of Part h. – PCC Circuit Breaker Specifications are met.
   f. The alternate location for the outdoor, visible/lockable, disconnecting means and fault interrupting device shall be permitted rather than the single disconnect switch at the point of common coupling. This disconnecting means shall be accessible by Allegheny Power personnel to operate, without notice, during system emergencies and outage restoration activities.
   g. Should the customer desire to operate the generator or distributed generation to supply their local load during emergency periods and utility outages as an island, the customer shall install a circuit breaker with remote tripping capabilities at the point of common coupling as the visible/lockable, load-break, disconnecting means and fault-interrupting device. The requirements of Part h. – PCC Circuit Breaker Specifications shall apply.
   h. PCC Circuit Breaker Specifications:
      i. Circuit breaker shall have remote tripping capability and be suitable for the application such as available fault current, load current, and etc. as determined by NEMA/UL standards.
Source: Distribution Engineering

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<th>Section Title</th>
<th>Subject Index</th>
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<td>05/11/05</td>
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<tr>
<td>Interconnection Policy And Guidelines – Distribution System Interconnection</td>
<td>35.0</td>
<td>9</td>
<td>10/05/06</td>
</tr>
</tbody>
</table>

ii. PCC Circuit breaker tripping circuit shall be wired with utility grade interconnecting relaying.

1. Interconnecting relaying shall consist of the following:
   a. 27 Under Voltage Relay
   b. 59 Over Voltage (phase to ground) Relay
   c. 59G Over Voltage (zero-sequence) Relay
   d. 81 Over and Under Frequency Relay
   e. 25 Synchronism Check Relay
   f. 67 AC Directional Overcurrent and/or 32 Directional Power (reverse power)

iii. This breaker shall also have overcurrent relaying suitable for the particular application.

iv. Potential transformers shall be on the line side of the breaker.

v. The breaker shall have local tripping capability such as a pushbutton or other means clearly identified for Allegheny personnel to operate as necessary.

i. Customer meters shown in Figure 2 are optional. However, if used, all metering CTs and PTs should be metering grade.

j. Retail Meter shall be metering package specified and installed by Allegheny Power as appropriate for the load, and particular rate schedule or for net metering as applicable.

3. Solar Photovoltaic Installations 30 kW and less: Figures 3 through 6 show the technical requirements for photovoltaic installations using pre-certified equipment as the interconnecting equipment. These figures apply to all new secondary distribution generator interconnections with an aggregate size of 30 kW or less at the point of common coupling. The interconnection equipment shall be listed according to UL 1741 – Inverters, Converters, and Controllers for Use in Independent Power Systems. While the National Electrical Code only recognizes this equipment for use with solar photovoltaic installations and fuel cells, this equipment may be used in the future with other technology such as small windmills. These interconnection requirements set forth in Figures 3 through 6 are intended for customers to offset load or for net metering and are not intended to sell energy to PJM.

   a. The point of common coupling (PCC) is at secondary voltage.
   b. The generator shall be a single-phase, UL Listed inverter or converter.
   c. The interface transformer shall be owned and installed by Allegheny Power. It shall be single phase (120/240 V.) on the secondary side.
d. Figures 3 and 4 show the visible/lockable, load-break, disconnecting means and fault-interrupting device at the PCC. It shall be accessible by Allegheny Power personnel to operate, without notice, during system emergencies and outage restoration activities. A power circuit breaker with remote tripping capabilities shall be permitted to act as the visible/lockable, load-break disconnecting means and fault-interrupting device.

e. Figures 5 and 6 show the alternate location for the outdoor, visible/lockable, disconnecting means and fault interrupting device shall be permitted rather than the single disconnect switch controlling all load and generation at the point of common coupling. This disconnecting means shall be accessible by Allegheny Power personnel to operate, without notice, during system emergencies and outage restoration activities.

f. Retail Meter shall be metering package specified and installed by Allegheny Power as appropriate for the load, and particular rate schedule or for net metering as applicable.
**Interconnection Policy And Guidelines – Distribution System Interconnection**

**Figure 1**

- **Primary Connection of Generation**
  - 2 MW or less on distribution system (PJM requirements)

- **Distribution Substation**
  - HV network system

- **Radial Distribution Line**
  - Tie to 2nd radial distribution line

- **Other Customers**
  - Radial distribution line

- **Retail Meter**
  - M or K (W, VAR, VARH)

- **Bi-Directional**
  - Vizable / Lockable load break disconnect and fault interrupting device or circuit breaker and disconnect switch

- **Customer Total Meter**
  - M or K (W, VAR, VARH)

- **Bi-Directional**

- **Load Meter**
  - M or K (W, VAR, VARH)

- **Generator**
  - M or K (W, VAR, VARH)

- **Transformer**
  - 27, 59, 81 Q (opt.)

- **Fault Protection**
  - OR INVERTER BASED PACKAGE WITH INTEGRATED GENERATOR PROTECTION
  - CEASE TO ENERGIZE CAPABILITIES
  - GENERATOR CONNECTED SOLIDLY

Source: Distribution Engineering
SOLAR PHOTOVOLTAIC NET METER INSTALLATION  
120/240 VOLT - SINGLE PHASE 30 KW OR LESS  
ONE LINE DIAGRAM

NOTES:

1. OUTDOOR DISCONNECTING MEANS SHALL BE CAPABLE OF BEING LOCKED IN THE OPEN POSITION BY ELECTRIC UTILITY PERSONNEL.

2. OUTDOOR DISCONNECTING MEANS SHALL BE WITHIN SIGHT AND WITHIN 10' OF METER SOCKET.

Figure 3
SOLAR PHOTOVOLTAIC NET METER INSTALLATION
120/240 VOLT - SINGLE PHASE 30 KW OR LESS
PERSPECTIVE DRAWING

Figure 4

Source: Distribution Engineering
Source: Distribution Engineering
Figure 6

Source: Distribution Engineering
8.0 ACCEPTANCE TESTING

1. The purpose of acceptance testing is to assure that the generator and generation equipment will operate successfully during all modes of operation including normal, abnormal, maintenance, emergency and contingent operations.

2. Allegheny Power personnel shall witness or perform acceptance testing prior to the generator or distributed generation being permitted to operate on the Allegheny Power system.

3. All generators and generation facilities shall pass the Allegheny Power acceptance test when the owner of the generation demonstrates that their equipment conforms to the requirements of this document and passes the requirements of Section 5. Interconnection Test Specifications and Requirements of IEEE 1547.

4. IEEE 1547.1 Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems contains the detailed requirements of acceptance testing.

5. Conformance tests shall be performed on all generators and generating equipment not pre-certified by a Nationally Recognized Testing Laboratory as suitable for utility interconnection meeting the intent of this manual release. A qualified third party testing organization at the expense of the owner/developer shall perform these tests.