POTOMAC ELECTRIC POWER COMPANY
WASHINGTON, DC

ENGINEERING REQUIREMENTS AND PERFORMANCE STANDARDS FOR INTERCONNECTION CUSTOMERS ON THE POTOMAC ELECTRIC POWER COMPANY SYSTEM

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I. Introduction

A. Interconnection Customers (IC's) are those intending to install generation that connects into the Pepco system. IC installations on the Pepco system requires that both Pepco and the IC meet certain minimum requirements for operation and safety. While the specific circumstances of each installation must be taken into account, this document describes the interconnection requirements, and includes several illustrative installations. Pepco and the licensed professional engineer for the IC will follow the requirements of this document when planning such an installation. The equipment and protection listed in the attached diagrams represent specific examples from which a final installation can be developed and approved. It is very important that Pepco review interconnections between IC equipment and the Pepco system early in the design stage. Pepco personnel will work closely with the IC from an early stage of the project to ensure compliance with these requirements.

For planning and estimating purposes, these examples include equipment typically required by the IC for the protection of its facilities but not required by Pepco; these facilities are identified on the diagrams and will be reviewed during the site-specific planning process.

B. These ENGINEERING REQUIREMENTS AND PERFORMANCE STANDARDS are based on typical equipment design. Pepco will entertain alternative equipment proposals and evaluate any which appears, upon preliminary review with the engineer of the party responsible for the generation equipment, to be feasible for the specific site and/or type of generation contemplated.

C. All generation installations and their interconnections must adhere to all applicable national and local codes, standards, rules and regulations and receive all applicable approvals from all appropriate governing bodies and be designed and constructed in accordance with Good Utility Practice.

D. If the generation is being installed under the Pennsylvania-New Jersey-Maryland Interconnection (PJM) tariff process, the IC must also meet all applicable PJM requirements.

E. An Interconnection Agreement or Interconnection Service Agreement, as appropriate, needs to be agreed to between the IC, Pepco, and, where appropriate, PJM.

F. Revenue metering requirements will depend on options for exporting and/or importing power selected by the IC and are outlined in Appendix "C". However, in no case will the IC generation facility's normal revenue meter(s) be permitted to run backwards due to power flow resulting from generation. In some cases two meters may be required to register power flowing into and out of the facility.

G. All details of complex generation systems with two or more Pepco supplies are not specifically addressed herein. However, the goals and criteria described in these requirements still apply. IC generation facilities with such systems should contact Pepco as early in the project as possible for additional information.

II. IC Generation System Classifications

A. In planning IC installations, proposed facilities can be categorized into one of two major groups, One Way Power Flow and Two Way Power Flow.

1. ONE WAY POWER FLOW
   An IC generation facility is classified as a "one way power flow" installation if the facility is configured such that its load is always greater than the generation capacity or the IC does NOT propose to export excess generated power through the Pepco interconnection. This type of installation will receive power through the Pepco interconnection but will never export power back into the Pepco system.

2. TWO WAY POWER FLOW
   An IC generation facility is classified as a "two way power flow" installation if the facility is configured such that its load is sufficiently variable or smaller than the generating capacity and the IC proposes to export its excess power. This type of installation provides for normal power flow in either direction, with the Pepco system delivering power to the IC or the IC exporting power into the Pepco system.

Note: The two way power flow category also covers installations whose normal power flow is only into the Pepco system, with no power received from the Pepco system to the IC.

B. The type of generation equipment used by the IC along with the power flow requirements determines what type of protective equipment and switching requirements are needed. Generation installations may use either Synchronous Generators or Signal Dependent Generators.

1. SYNCHRONOUS GENERATORS
   This type of generation equipment is capable of operation independent of any signal from Pepco and can supply power to the IC's load when the Pepco supply is unavailable. Special protection must be installed to ensure that synchronous generators do not keep an isolated part of the Pepco system energized when the supply feeder's circuit breaker is open at the Pepco source station. This condition is called "islanding" and is not permitted under any situation to ensure public safety, the safety of Pepco employees, and to prevent possible damage to other equipment. Two Way Power Flow installations most frequently use synchronous generators.
2. SIGNAL DEPENDENT GENERATORS

This type of generation equipment requires a signal from the Pepco system to operate. It is not generally capable of supplying power to the IC's load upon loss of the Pepco supply. The protection of this type of equipment is typically less complex than required for synchronous generators. Induction generators and inverters are usually included in this category.

III. System Classification Configurations

A. Generation systems connected to the Pepco system are divided into the following groups; One Way or Two Way Power Flow, with Synchronous or with Signal Dependent generation. These categories were discussed in Sections II.A. and II.B. The voltage at which the interconnection occurs, generally classified as either transmission, subtransmission or distribution, also determines the complexity of the interconnection.

B. Four diagrams are included to show examples of IC generation intertie stations:

Figure A:	One or two way power flow, small, signal dependent generator
Figure B:	One way power flow, distribution, synchronous generator
Figure C:	Two way power flow, subtransmission, synchronous generator
Figure D:	Two way power flow, transmission, synchronous generator

A fifth figure, Figure E, is also included to show circuit breaker identification and explanation.

Note that the diagrams are illustrative and do not cover all acceptable operating arrangements, including transformer connections. They do not show all of the required interconnection equipment. Specific requirements must be determined for each installation.

IV. General System Protection Requirements

A. In the course of reviewing a proposed IC installation, certain critical concerns must be addressed. These issues can affect the viability of a proposed interconnection and should, therefore, be reviewed in the early planning stages of the project.

1. The effect of fault contributions from the IC generation on the interrupting and momentary ratings of the Pepco supply busses and other equipment must be evaluated. IC generation fault current flows cannot be allowed to overduty existing Pepco equipment or the equipment of other Pepco customers. Fault current contribution from large IC motors may also be included in the evaluation. When the calculated fault current level due to the IC’s installation exceeds the short-circuit rating of Pepco’s equipment, action must be taken to reduce the calculated fault-current level to within the equipment’s rating. A passive solution is required that does not depend on testing to check its effectiveness and availability as a mitigation solution. Typical solutions include increase in transformer impedance, the installation of fixed reactance,

elimination of bus ties and the replacement of overdutied equipment with higher rated equipment.

2. In the case of two-way power flow installations, Pepco must be able to absorb the power proposed to be received into the Pepco system. The effect of power flow from IC generator installations on Pepco's load flows must be studied, and may affect the design of the interconnection station, including interconnection location and voltage, as well as the IC's generation system.

3. Any changes needed on the Pepco system to alleviate problems associated with the IC installation, such as overdutied or overloaded equipment, must be done at the IC's expense.

B. Certain protective devices, including an interrupting device and protective relays, will be required. They must be approved by Pepco and must be installed at any location where an IC desires to operate generation equipment connected to the Pepco system.

The **intertie circuit breaker** is defined as the IC's circuit breaker separating the generation system (or generation equipment) from the Pepco system. It is the responsibility of the IC to designate a proposed intertie circuit breaker, which must be reviewed for acceptability by Pepco. Final review and approval of the designation of the intertie circuit breaker is the responsibility of Pepco.

The **intertie station** for the purposes of this document is defined as the IC facility including the intertie breaker. The protection of the IC system on their side of the intertie breaker is the sole responsibility of the IC.

C. The protection and controls applied at the intertie must be designed to automatically separate the generation system from the Pepco system for the following conditions:

1. For faults on the Pepco system within the zone of protection encompassing the Point of Interconnection (POI) which produce infeed from the generation equipment into the Pepco fault. The **Point of Interconnection** means each ownership point of demarcation where energy, capacity and ancillary services are transferred between the intertie station and the Pepco electric system.

2. For intolerable voltage and frequency conditions on Pepco's connected circuits.

3. For faults or other intolerable conditions on the IC's generation system.

4. Whenever the Pepco feeder is isolated from the Pepco system, either by opening its circuit breaker(s) at the Pepco source stations(s) or by any other means.

D. The design and application of the required protective relaying is based on a "Single Contingency" philosophy. This means that adequate relaying and control

redundancy, including batteries, must be included so that the failure of any single component in the proposed power and/or protection system, including any one protective relay or its associated communication means, such as a channel of tone transfer trip equipment, an individual fiber-optic circuit or an individual leased line [Communication Channel], will not prevent proper isolation of the faulted equipment.

E. The IC is fully responsible for protecting its equipment in such a manner that automatic or manual circuit reclosing, faults, or any other disturbance on the Pepco system or the IC's generation system does not cause damage to its equipment. The IC generator controls must include automatic voltage regulation equipment that is inherently self-protecting under all operating conditions.

F. The IC generation shall not maintain supply to a Pepco circuit following the opening (isolation) of the Pepco circuit. The IC generation protection and control systems must detect this condition and automatically trip the intertie breaker.

G. All relay setting calculations and coordination at the intertie will be the responsibility of the IC. The IC must submit the following information to Pepco for review and approval, prior to setting the intertie relays. Pepco requires two months to review proposals of this type.

1. Detailed one-line wiring diagram showing Pepco's supply feeder(s), busses, transformers, and switchgear up to the intertie breaker, as well as the generation system up to the intertie breaker. Protective relaying device numbers, transformer connections and ratings must be shown, and the intertie breaker clearly identified.
2. Three-line AC elementary control diagram showing connections of current transformers, voltage transformers and relays.
3. Operating sequence and procedure, including DC elementary control diagrams of proposed circuit breaker trips, synchronizing and transfer schemes. This should show how the generation system is proposed to transfer from the Pepco supply to the IC generator supply, as well as from the IC generator supply to the Pepco supply.
4. Information regarding the generation equipment grounding system.

H. The initial checkout and setting of the protective devices at the intertie will be witnessed by Pepco. Pepco will also verify/witness appropriate controls, interlocks, etc., before releasing the interconnection for service.

I. Pepco reserves the right to inspect, with twenty-four hours notice, all protective equipment and related controls including relays, circuit breakers, batteries, teleprotection systems, etc., at the intertie station. Inspection may include the tripping of the intertie breaker by the protective relays.

V. <u>One Way Power Flow System Protection Requirements</u>

A. One way power flow installations connected to the Pepco system will require

protection schemes consistent with the existing Pepco relaying schemes. To satisfy protective relaying requirements stated in Section IV, the required IC generation equipment and intertie protection schemes may require Communication Channels for transfer trip. These Communication Channels, depending on interconnection voltage and site location, may be dedicated leased telephone circuits, power line carrier, microwave, fiber optic cable or other means. The Communication Channel requirements are subject to redundancy and geographically alternate routing requirements, consistent with existing Pepco single contingency failure standards as previously described.

1. One way power flow installations which require Communication Channels will generally require dedicated supply feeders. Dedicated supply feeders provide discrete and fixed system arrangements necessary for implementation of Communication Channels.

2. Pepco's 3-phase, 4-wire distribution system (radial system, supplies medium voltage customers, usually 13.8kV) is designed to allow routine switching of customers from one feeder to another to permit reliable operation of the system. Since this switching philosophy precludes use of transfer trip, only Signal Dependent Generators or one-way power flow installations can be connected to the 3-phase, 4-wire distribution system.

3. Pepco's LVAC network systems (low voltage, AC, network system which supplies low voltage customers, usually 480V and 208V) are designed to prevent any power flow from a customer into Pepco's primary supply feeders. Consequently, only one-way power flow installations, or two-way, signal dependent, UL-1741 approved, inverter based generation installations up to 10kW per customer can be connected to the LVAC network systems. (App. A, Ref.5) All net energy metering installations will be evaluated on a case by case basis in order to prevent jeopardizing system integrity and to address safety concerns. An engineering analysis will be performed for all such installations, prior to their connection to the Pepco System. Any customer generation facilities that cause cycling of network protectors or adversely impact any other customer or any part of the Pepco system will not be permitted to operate on the LVAC network systems as set forth in IEEE Standard 1547, Section 4.1.4.2.

4. Requirements for connections to the Pepco system at higher than 13.8kV will be determined on a case by case basis and will depend on the generation facility's location and system configuration.

VI. One Way Power Flow Switching Requirements

A. Switching (tripping only) of the intertie breaker must be under the operating control of Pepco. Pepco will establish specific operating controls on an individual basis.

Pepco reserves the right to open the intertie breaker without prior notice in any of the following circumstances:

1. Emergency conditions (local, system wide or regional).

2. Inspection of the intertie station reveals an unsafe condition.

3. The IC generation system interferes with other customer's systems, or with the operation of the Pepco system.

B. Pepco's requirements for supervisory control and data acquisition equipment as well as the associated metering and communication equipment will be specified on an individual basis in appropriate detail in the respective Interconnection Agreement or Interconnection Service Agreement, as appropriate,

C. Pepco reserves the right to open the intertie breaker with twenty-four hour notice if:

1. Inspection of intertie station and protective equipment reveals a lack of maintenance, lack of records of maintenance or any other conditions not meeting these requirements.

2. An outage is scheduled on the Pepco supply feeder. From time to time, Pepco must remove its lines from service for reasonable time periods. These planned outages are for purposes such as testing relays, rearranging, modifying or constructing lines, and maintaining lines or station equipment. Pepco and the IC will mutually develop a planned outage schedule. If agreement cannot be reached, Pepco reserves the right to set the outage date and the IC must cooperate.

D. The intertie circuit breaker will be allowed to close only if the IC generation side of the intertie breaker is deenergized. The only circuit breaker required for interconnection is the intertie circuit breaker shown in Figures "B", "C" and "D". The operation of all circuit breakers is explained in Figure "E", without the required protection.

For IC generation facilities with multiple PEPCO supplies, the main (incoming) breakers are typically designated as the intertie breakers. If these supplies are networked through a low voltage bus, any intertie breaker may be permitted to close when the generation system side of the intertie breaker is energized. Additional requirements may be established on a case by case basis.

E. The IC shall be solely responsible for properly synchronizing its generation equipment to the Pepco system. Improper synchronization with the Pepco system is at the IC's risk and liability and any damage that may result to its equipment, other customers' equipment or to the Pepco system will be the IC's responsibility.

F. The generation equipment shall not be permitted to energize or maintain supply to a Pepco isolated circuit.

VII. Two Way Power Flow System Protection Requirements

A. Two way power flow installations connected to the Pepco system will require protection schemes consistent with the existing Pepco relaying schemes. To satisfy protective relaying requirements stated in Section IV, the required generation equipment and intertie protection schemes may include Communication Channels for transfer trip. These Communication Channels, depending on interconnecting voltage and site location, may be dedicated leased telephone circuits, power line carrier, microwave, fiber optic cable or other means. The Communication Channel requirements are subject to redundancy and geographically alternate routing requirements, consistent with existing Pepco single contingency failure standards as previously described.

1. Two-Way Power Flow installations using synchronous generators will require Communication Channels. Two-Way Power Flow installations with signal dependent generators may require Communication Channels, depending on location, generation system conditions, etc.

2. Two way power flow installations which require Communication Channels will generally require dedicated supply feeders. Dedicated supply feeders provide discrete and fixed system arrangements necessary for implementation of Communication Channels.

3. Pepco's 4-wire distribution system is designed to allow routine switching of customers from one feeder to another and from one substation to another, in order to permit reliable and flexible operation of the system. Since this switching philosophy precludes use of transfer trip, two-way power flow (non-signal dependent power flow) installations cannot be connected to the 4-wire distribution system. However, two-way signal dependent or UL-1741 inverter based generation can be connected to the 4-Wire distribution system.

4. Pepco's LVAC network systems are designed to prevent any power flow from a customer into Pepco's primary supply feeders. Consequently, two-way power flow (non-signal dependent power flow) installations can not be connected to the LVAC network systems. Only one-way power flow installations, or two-way, signal dependent, UL-1741 approved, inverter based generation installations up to 10kW per customer can be connected to the LVAC network system. (App. A, Ref. 5) Any customer generation facilities that cause cycling of network protectors or adversely impact any other customer or any part of the Pepco system will not be permitted to operate on the LVAC network systems.

5. Requirements for connections to the Pepco system at higher than 13.8kV will

be determined on a case by case basis and will depend on the location of the generation facility and system configuration. Examples, without all required protection, are shown in Figure “C” for subtransmission interconnections, and Figure “D”, for transmission interconnections.

VIII. Two Way Power Flow Switching Requirements

A. Switching (tripping only) of the intertie breaker must be under the operating control of Pepco. Specific operating controls will be established by Pepco on an individual basis. Pepco reserves the right to open the intertie breaker without prior notice in any of the following circumstances:

1. Emergency conditions (local, system wide or regional).

2. Inspection of intertie station reveals an unsafe condition.

3. The generation system interferes with other customer’s systems, or with the operation of the Pepco system.

B. Pepco's requirements for supervisory control and data acquisition equipment as well as the associated metering and communications equipment will be specified on an individual basis in appropriate detail in the respective Interconnection Agreement or Interconnection Service Agreement, as appropriate.

C. Pepco reserves the right to open the intertie breaker with twenty-four hour notice if:

1. Inspection of intertie station and protective equipment reveals a lack of maintenance, records of maintenance or any other conditions not meeting these requirements.

2. An outage is scheduled on the Pepco supply feeder. From time to time, Pepco must remove its lines from service for reasonable periods. These planned outages are for purposes such as testing relays, rearranging, modifying or constructing lines, and maintaining lines or station equipment. Pepco and the responsible party for the generation will mutually develop a planned outage schedule. If agreement cannot be reached, Pepco reserves the right to set the outage date and the generating facility must cooperate.

D. The intertie circuit breaker will be allowed to close only if the generation system side of the intertie breaker is deenergized. For radial or tapped circuits, the only circuit breaker required for interconnection is the intertie circuit breaker shown in Figures “A” and “C”. The operation of all circuit breakers is explained in Figure "E", without the required protection.

E. For IC generation facilities with multiple PEPCO supplies, if the intertie breakers are designated as the main (incoming) breakers associated with the multiple incoming Pepco circuits which terminate at an electrically solid high voltage bus or are networked through the low voltage bus, any intertie breaker may be permitted to close when the generation system side of the intertie breaker is energized. Additional requirements may be established on a case by case basis.

F. The IC shall be solely responsible for properly synchronizing its generation equipment with the Pepco system.

G. The IC generation equipment shall not be permitted to energize or maintain supply to an isolated Pepco circuit.

IX. System Protection Requirements for Short Duration Closed Transition Switching Applications

A. A short duration closed transition (make-before-break) switching application involves switching the IC facility's load from the Pepco supply to the IC generation supply and when switching from the IC generation to the PEPCO supply such that the two supplies are paralleled for a time spanning less than 1 minute.

B. IC generation facilities may propose to use an Automatic Transfer Switch (ATS) to implement short duration closed transition switching. Pepco will consider the application of such a switch on a case by case basis, considering:

1. The impact that the operation of an ATS would have on personnel safety, the operation of the Pepco LVAC network system, and other customers on the Pepco system.

2. The possibility that a failed automatic transfer switch could result in continuous paralleling of both supplies, simultaneous loss of both supplies, or simultaneous tripping of both supplies.

3. All applicable safety and industry standards.

4. The ATS manufacturer's current ratings and voltage ratings during closed transition switching.

C. For those IC generation facilities whose only interest is to implement closed transition switching via an ATS, additional relaying may not be required if the proposed ATS is capable of switching the supplies in less than 100 milliseconds, and has a retrip feature that will automatically trip the necessary breakers to prevent continuous paralleling if the ATS malfunctioned in any manner, and if the generation facility's protection system is adequately designed for a one way power flow installation.

D. For those IC generation facilities whose installations are supplied by multiple Pepco

LVAC primary feeders, the generation facility's electric system design must incorporate the following considerations:

1. The Pepco LVAC primary feeders must not be paralleled at any location within the generation facility's distribution system.

2. The generation facility's on-site supply must not be paralleled with any Pepco supply at any location other than at the intertie location.

X. Switching Requirements For Short Duration Closed Transition Switching Applications

A. Pepco must have opening control of an intertie breaker, which will separate the Pepco system from the IC generation facilities system. Pepco reserves the right to open the intertie breaker(s) without prior notice in the event that any of the following circumstances should occur:

1. Emergency conditions (local, system wide, or regional).
2. Inspection of the intertie breaker reveals an unsafe condition.
3. The IC generation system interferes with other customer's systems, or with the operation of the Pepco system.
4. Failure of the closed transition switching device which would result in continuous paralleling of the Pepco system with the IC generation facility system.

Pepco reserves the right to open the intertie breaker with twenty-four hour notice if an outage is scheduled on the Pepco supply feeder.

XI. General Requirements

A. The IC has full responsibility for the routine maintenance of its generation, protection and control equipment. Complete maintenance records for the service entrance and intertie equipment (App. A, Ref. 8) must be maintained by the generation facility and must be available for Pepco review upon twenty-four hours notice. If the generation facility fails to provide proper routine maintenance the IC must cease parallel operation until such maintenance is performed.

B. The interconnection of the IC with the Pepco system shall not cause any reduction in the quality of service, which Pepco provides to other customers. No abnormal voltages, frequencies, harmonics or interruptions will be permitted. The maximum voltage waveform distortion caused by the generation equipment shall be limited to 5% measured at the generation facility-Pepco intertie, including a maximum of 1% phase voltage unbalance. (App. A, Refs. 1, 2) Total voltage harmonic distortion shall be limited to 5%, with single harmonic distortion not exceeding 3% at the generation facility interface. (App. A, Ref. 9) The generation facility may propose any intertie equipment which can be demonstrated to enable the installation to meet and maintain these standards. These requirements must be verified by the generation facility and witnessed by PEPCO, initially and periodically. Periodicity will be

determined based on initial measurements.

C. Pepco reserves the right to provide voltage set points for the IC generation voltage controls. If a setpoint is required, the Pepco System Operator will provide the setpoint prior to the initial parallel operation of the generator and from time to time as required for reliable operation.

D. The IC generation facility's power factor, as measured at the intertie point, must be between 0.85 lagging and unity, both with and without the generation equipment on-line. This requirement must be verified by the generation facility and witnessed by PEPCO, initially and periodically, or as specified in the Interconnection Agreement or Interconnection Service Agreement, as appropriate. Periodicity will be determined based on initial measured values. A power factor of 0.85 or above is a standard Pepco requirement as approved by the Public Service Commissions of Maryland and the District of Columbia.

E. The configuration of Pepco's electric system is such that IC generation equipment will generally require isolation from the Pepco system by a dedicated power transformer. Isolation is required at most locations to achieve the following: (App. A, Ref. 3)

1. Decrease voltage variations experienced by other customers.

2. Attenuate harmonics, particularly on those installations using inverters.

3. Reduce the effects of fault currents on both the generator and other customers on the Pepco system.

4. Decrease the likelihood of self-excitation where an induction generator is used.

5. Isolate the zero sequence circuit of the generation system from the zero sequence circuit of Pepco.

Pepco will evaluate generation proposals for achieving the foregoing performance criteria without use of an isolating transformer with specific reference to the proposed generation equipment and location on the Pepco system. If an isolating transformer is necessary, Pepco will determine whether this transformer shall be delta-connected, wye-connected solidly grounded, grounded through an impedance or ungrounded at the interconnection line voltage.

F. Direct current generators may be operated in parallel with the Pepco system through a DC to AC inverter. Harmonics generated by a DC generator-inverter combination must not cause any reduction in the quality of service provided to other customers, and must adhere to the previously specified 5% limit on wave form distortion. Additionally, if commutation notches are present, the volt-seconds area of the notch

must be limited to less than 3400 percent volts-microsecond. (App. A, Ref. 2) These requirements must be verified by the generation facility and witnessed by Pepco initially and periodically. Periodicity will be determined based on initial measurements.

G. If it is necessary for Pepco to do work on the IC generation facility's premises, Pepco will inspect the work area. If the inspection reveals hazardous working conditions, the IC must correct the condition so that Pepco can perform the work. Note that Pepco requires a minimum of two days notice for unit scheduled outages.

H. The IC must promptly notify Pepco well in advance of ever making any changes affecting the generating facility's capacity, short-circuit contribution, operation, protection and control, and configuration that could impact Pepco and/or the interconnection and/or that might trigger the need for a corresponding action on Pepco's part. The IC shall submit to Pepco any and all plans and specifications that Pepco may reasonably request related to such changes. Such specifications and plans shall be submitted by the IC to Pepco at the time that the IC submits its plans under the PJM Tariff related to the changes but no later than one hundred twenty (120) days prior to commencing such proposed changes**.** Failure to coordinate such actions with Pepco may result in the generating facility not being allowed to operate in parallel with the Pepco system.

I. All work in or on existing Pepco substations and on Pepco electrical facilities in public space will be designed, constructed and installed by Pepco or at Pepco's direction at the discretion of and as determined by Pepco. Pepco reserves the right to build structural facilities in public space, but upon approval by Pepco, the IC may build structural facilities in public space for Pepco ownership in accordance with Pepco Procedure 2.27 titled "Customer Built Structural Facilities in Public Space".

XII. Description of Protection and Relay Setting Requirements

A. The following protective devices may be applicable to a generation site. Discussions between Pepco and the generation facility are necessary to determine which relays are required for each specific application. Multifunction relays which incorporate several functions in one unit may be acceptable subject to Pepco's approval, provided that the installation is consistent with existing Pepco single contingency failure standards as previously described. Note that the required generation facility protection and the attached Figures "A", "B", "C", and "D" do not necessarily

include all possible protective devices listed below.

1. Phase Distance and Timer
   Detects faults on the Pepco system by measuring voltage and current flow out of the generation facility, operating instantaneously for near faults and after a time delay for remote faults. Applicable relay settings are determined by system configurations and fault levels.

2. Transformer Primary Phase and Ground Overcurrent
   Provides time delayed backup protection for faults on the generation system primary or transformer. These relays operate on current flow, which is above normal.

   Phase overcurrent relays are set for approximately 200% of transformer rated current. Ground overcurrent relays are set for approximately 100% of transformer rated current. Time delays are coordinated with other system relays and are affected by fault current magnitudes.

3. Over/Under Voltage
   Detects Pepco supply feeder faults or deenergization and ferroresonance conditions. (App. A, Refs. 6, 7)

   Overvoltage relay is generally set at 110% of nominal system voltage. Undervoltage is generally set at 80% of nominal system voltage. Time delay is usually 5 to 10 seconds.

4. Transformer Secondary Phase and Ground Overcurrent
   Provides time delayed backup protection for faults on the generation system by operating on current flow above normal.

   Settings are similar to those of the Transformer Primary Phase and Ground Overcurrent Relays.

5. Stuck Breaker and Timer
   Detects failure of intertie circuit breaker to open following operation of any other protective relay.

   Set to trip at approximately 200% transformer rated current with time delay.

6. Over/Under Frequency
   Monitors the generation system frequency and operates whenever the frequency goes above or below nominal. Protects against ferroresonance and other system disturbances. (App. A, Refs. 6, 7) The primary function of the frequency relays is to assure the safety of personnel and operating equipment.

   Underfrequency protection for some installations may be coordinated with Pepco's Load Shedding Program, i.e. 57.5Hz and 5-second time delay underfrequency settings. For all other generation installations, frequency

relays should be set to trip whenever the system frequency deviates by more than 1Hz. The time delay for operation must be 5 seconds or less. Actual settings will depend on type of relays and equipment used. Note that relays with inverse time characteristics as well as those with definite time characteristics are acceptable.

7. Phase Directional Overcurrent and Power Directional
Prevent fault current or excessive power flow into the Pepco system. In One-Way power flow installations relays should be set to trip the intertie breaker when any power flows into the Pepco system. For Two-Way power flow installations relays should be set above the anticipated current to be exported to Pepco, to operate for faults on the Pepco supply feeder.

B. Small IC generation installations must design their protective schemes with consideration that there may be fuses, switches, sectionalizers, or automatic reclosers in the line at or between the Pepco substation and the intertie station.

C. Signal Dependent generators do not generally have the capability to run without the utility supply (self-excitation). However, if industry experience or special tests of the particular generation facility indicate that it can under any circumstances continue to generate power after the removal of utility supply, protective measures (similar to those required for synchronous generators as discussed above) must be installed to prevent parallel operation until the system is modified to eliminate the possibility of self-excitation.

Appendix A - References

1. ANSI/NEMA Standards Publication No. MG1- 1993; "Motors and Generators"; Part 14, Page 8, Fig. 14-1; and Part 20, Page 10, Fig. 20-2; National Electrical Manufacturers Association, 2101L Street, N. W., Washington, D. C.

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3. Park, G. L. and Zastrow, O.; "Interconnection Issues Concerning Consumer-owned Wind Electric Systems"; IEEE Power Engineering Society paper; 1981 Transmission and Distribution Conference; Sept. 1981

4. Applied Protective Relaying, Westinghouse Electric Corp., 1979; Chapters 1, 8 and 10; Westinghouse, Relaying-Instrument Division, Coral Springs, FL 33060

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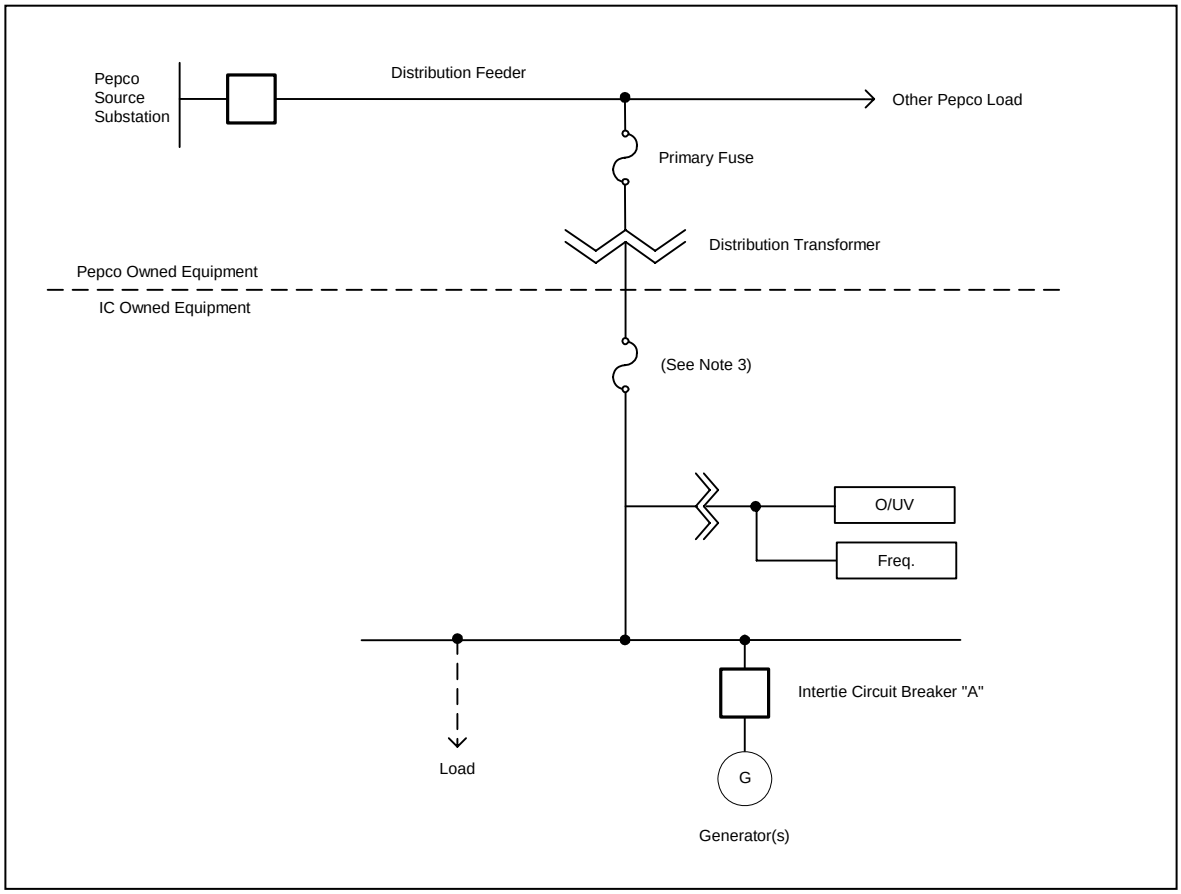
7. Wagner, C. E., Feero, W. E., Gish, W. B. and Jones, R. H.; Relay Performance in DSG Islands; IEEE 1988 Winter Power Meeting; Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, NY 10017

8. Guide Specification for Inspection and Test of Customer Owned High Voltage Service Equipment. Pepco SEGS066

9. ANSI/IEEE Std. 519-1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

10. IEEE 1547-2003, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems.

Appendix B. Figures



Protection	Trips Breaker	Typical Settings
Over/Under Voltage (O/UV)	A	110% of Nominal Overvoltage 80% of Nominal Undervoltage
Over/Under Frequency (FREQ)	A	61Hz Overfrequency 59Hz Underfrequency

Notes:

1. Required metering is not shown.
2. This protection is only suitable for generators unable to function without an energized Pepco supply.
3. "Service Equipment - Disconnecting Means" per Article 230, Section "H" of National Electric Code. This equipment shall include its own overcurrent protective device.

FIGURE "A" - One Way and Two Way Power Flow Distribution System
Small, Signal Dependent Generators
Typical Installation

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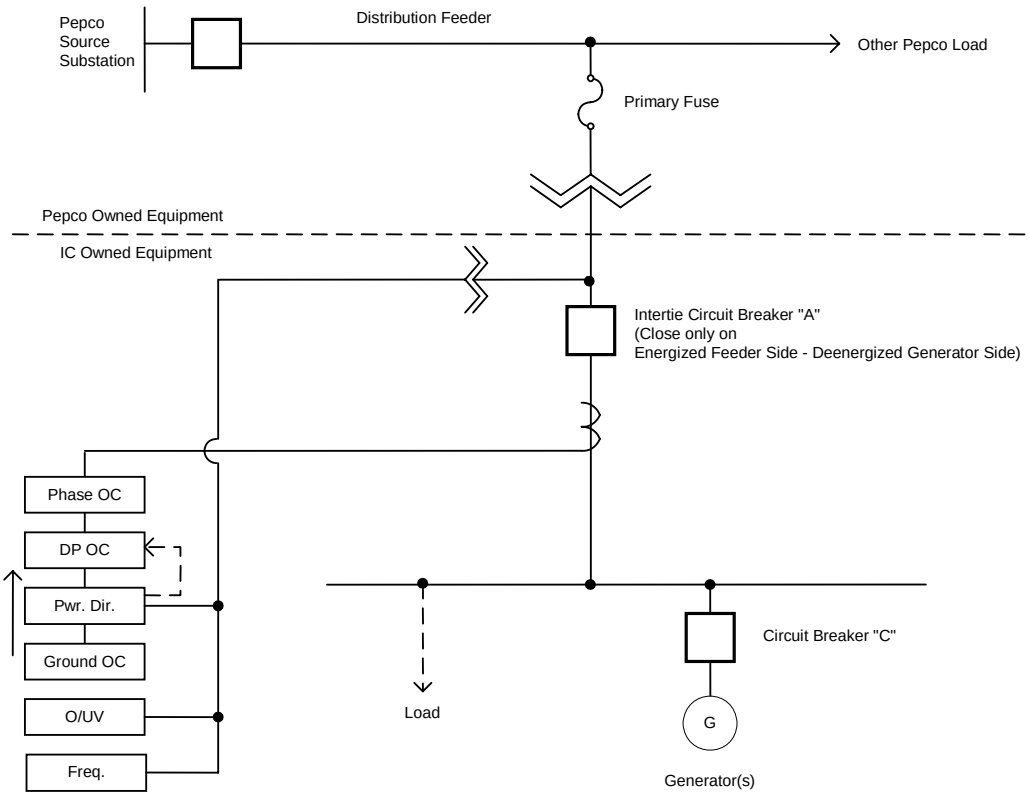

Protection	Trips Breaker	Typical Settings
Phase Overcurrent (Phase OC)	A and/or C	200% of Equipment Rating
Directional Phase Overcurrent (DP OC)	A and/or C	Less than 1% of Equipment Rating
Power Directional (Pwr Dir)	Supervises DP OC	Trips only for Power Flow into Transformer and Pepco System
Ground Overcurrent (Ground OC)	A and/or C	100% of Equipment Rating
Over/Under Voltage (O/UV)	A and/or C	110% of Nominal Overvoltage 80% of Nominal Undervoltage
Over/Under Frequency (FREQ)	A	61Hz Overfrequency 59Hz Underfrequency

Notes: 1. Required metering is not shown.
2. Ground Overcurrent Relay (Ground OC) required for three phase installations only.
3. A protective device known as a low voltage A. C. Network Protector may be used instead of the relays and Breaker “A”.

FIGURE “B” - One Way Power Flow
Synchronous Generator
Typical Distribution Installation

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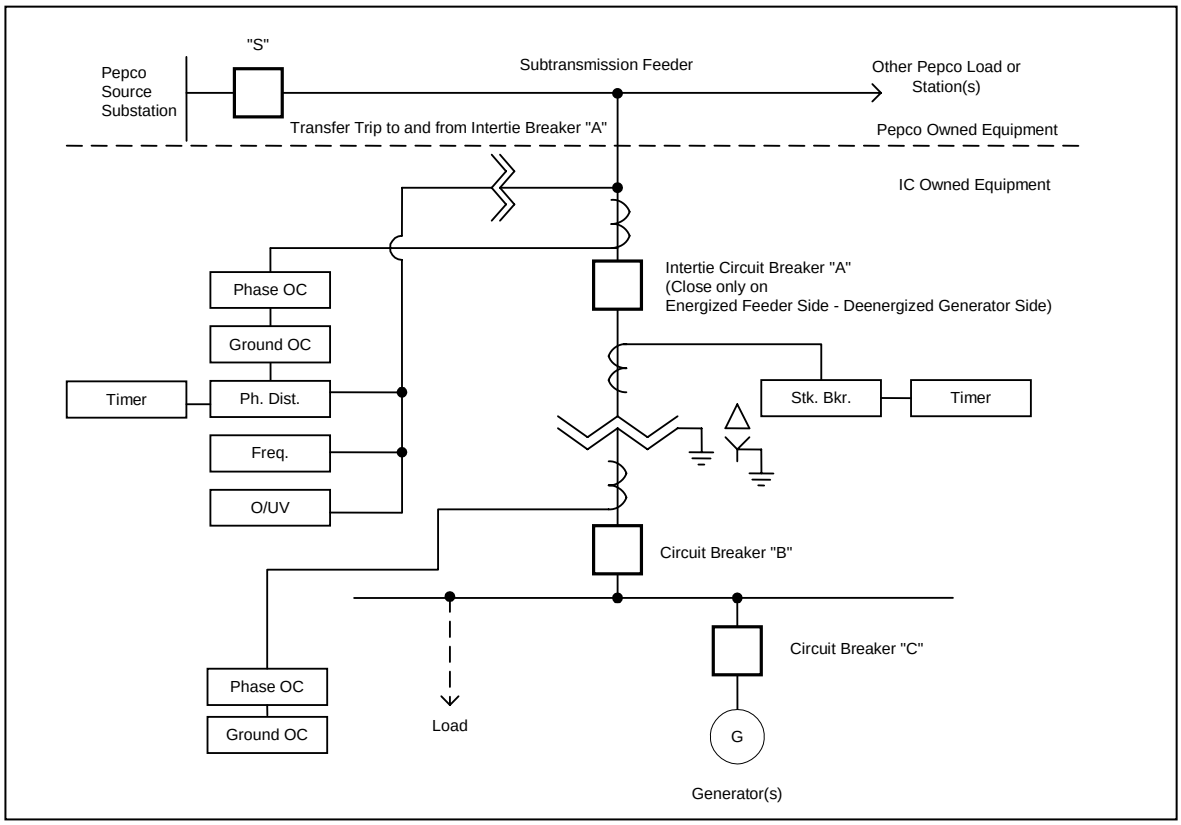

Protection	Trips Breaker	Typical Settings
Over/Under Frequency (FREQ)	A	61Hz Overfrequency 59Hz Underfrequency
Over/Under Voltage (O/UV)	A	110% of Nominal Overvoltage 80% of Nominal Undervoltage
Primary Phase Overcurrent (Phase OC)	A	200% of Transformer Rated Current
Primary Ground Overcurrent (Ground OC)	A	100% of Transformer Rated Current
Phase Distance & Timer (Ph. Dist.) (Timer)	A	80% of Impedance to "S" @ 0 seconds Time Delay 150% of Impedance to "S" @ 0.5 seconds Time Delay
Secondary Phase Overcurrent (Phase OC)	A or B	200% of Transformer Rated Current
Secondary Ground Overcurrent (Ground OC)	A or B	100% of Transformer Rated Current
Stuck Breaker & Timer (Stk. Bkr.) (Timer)	B or C and Transfer Trip to S	200% of Transformer Rated Current @ 0.25 sec. Time Delay

Notes: 1. Required metering is not shown.

FIGURE "C" -Two Way Power Flow – Subtransmission
Synchronous Generator
Typical Installation

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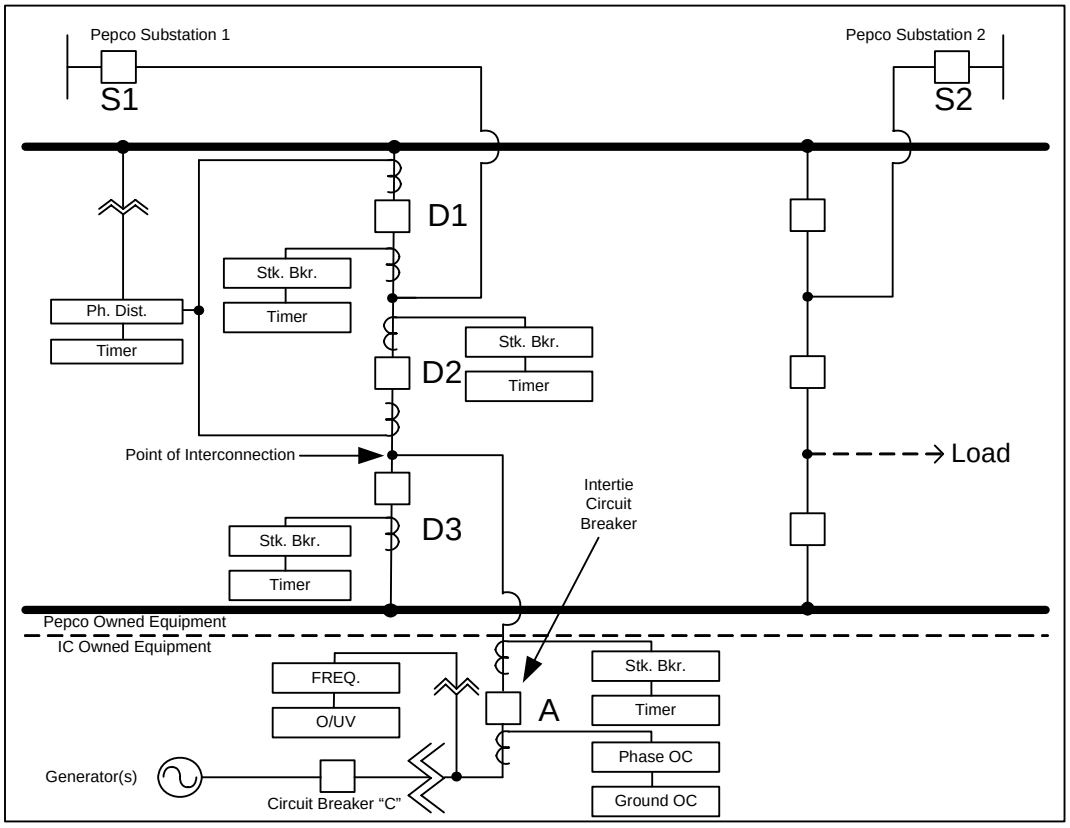

Protection	Trips Breaker	Typical Settings
Phase Distance & Timer (Ph. Dist.) (Timer)	D1 and D2 Transfer Trip S1	80% of Impedance to"S1" @ 0 seconds Time Delay 150% of Impedance to "S1" @ 0.5 seconds Time Delay
Over/Under Frequency (FREQ)	A	61Hz Overfrequency 57.5 Hz Underfreq @5 sec. Time Delay
Over/Under Voltage (O/UV)	A	110% of Nominal Overvoltage 80% of Nominal Undervoltage
Phase Overcurrent (Phase OC)	A	200% of Rated Current
Ground Overcurrent (Ground OC)	A	100% of Rated Current
Stuck Breaker & Timer (Stk. Bkr.) (Timer)	All adjacent breakers	200% of Rated Current @ 0.25 seconds Time Delay

Notes: 1. Not all required protection is shown; e.g., bus protection, second sets of phase distance and stuck breaker relays.
2. Required metering is not shown.
3. Breakers D1 and D2 must open whenever Breaker S1 opens.

FIGURE "D" - Two Way Power Flow - Transmission Synchronous Generator Typical Installation

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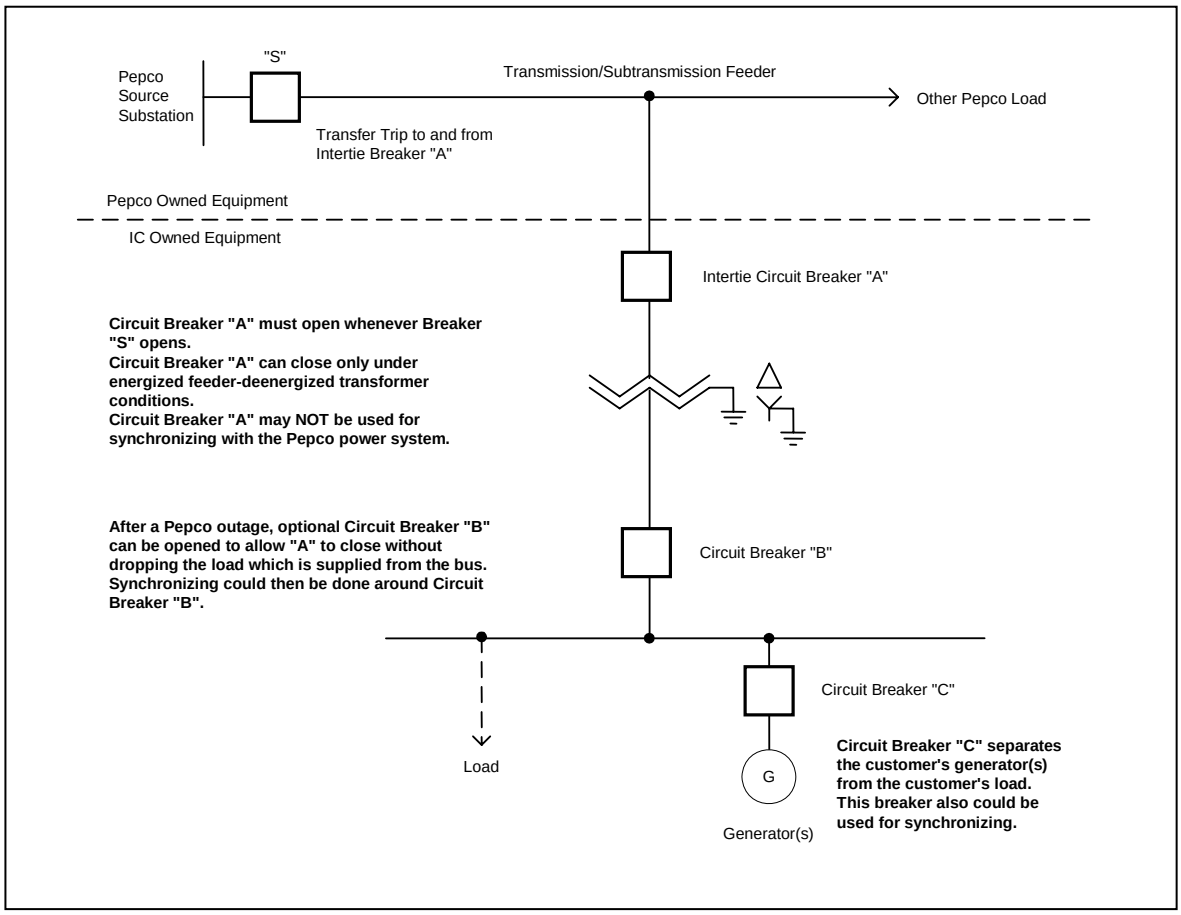

Notes: 1. Required protective relaying and metering is not shown.

FIGURE "E" - Circuit Breaker Identification and Explanation
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Appendix C – Communications and Metering Requirements

Information Reporting

It is not possible to define the specific requirements for each facility without an evaluation of the proposed facility. Pepco will evaluate the specific installation and determine the extent of the requirements as appropriate.

Metering Requirements

All generators connecting to the Pepco system are required to install and operate metering and related equipment equivalent to those required by PJM regardless of whether the generator plans to interact with the PJM market or system. PJM metering and data communication requirements are available from the PJM website, www.pjm.com, and are described in PJM Manual M-14, Generator Interconnections and Operations.

Generators less than 10 MW not planning to interface with PJM are not required to supply real-time telemetry. Revenue-related information is necessary and Pepco can arrange and install, at generator's expense, Pepco's standard interval metering equipment read by Pepco.

Generators 10 MW or greater must supply real-time and revenue information. If the unit is reporting directly to PJM, it may be possible for Pepco to obtain some or all of the required information from PJM with the approval of the generator. Pepco will evaluate the generator's request to obtain data from PJM. Real time information will be collected at a two-second data rate, and revenue information will be collected hourly.

Data Communications

The generator shall provide telemetered data via Distributed Network Protocol (DNP 3) to the Pepco Control Center Energy Management System (EMS). Communications is typically by 4 wire circuit from the generator site to the Pepco Control Center at generator's expense, generally obtained from public carrier. Pepco requires a DNP compatible modem at the Control Center for each communication circuit and assesses an additional EMS interface fee for each circuit. Generators 50 MW or greater are required to supply data over redundant communication lines.

Metering for Individual Generators

Revenue Metering

The minimum data for revenue metering requires:

Hourly compensated MWh generated net of station use
Hourly compensated MVARh generated net of station use

Real-time Data

Real-time data required include all data determined by Pepco to be necessary for system security and stability or accurately estimate Pepco system real-time load. The minimum data for real-time include instantaneous values for:

Net MW
MVAR
Voltage
Current in Amperes
Equipment status (i.e., generator breaker open/close)

Pepco also requires trip capability for generator and/or inter-tie breaker

Voice Communications Requirements

In addition to the voice communication requirements of the Interconnection Agreement or Interconnection Service Agreement, as appropriate, Pepco may require voice communication link over secure Pepco communications infrastructure. Additionally, radio communication capability over Pepco equipment may be required.