



# **EXELON UTILITIES TRANSMISSION FACILITY INTERCONNECTION REQUIREMENTS**



**In compliance with NERC standard FAC-001-3**

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## Transmission Facility Connection Requirements

### INTRODUCTION

This document was developed by Exelon Utilities to comply with the North American Electric Reliability Corporation (NERC) Reliability Standard FAC-001-3 Facility Interconnection Requirements for Transmission Owners. Facility Interconnection and performance requirements are established to avoid adverse impacts on reliability of the Bulk Electric System. These requirements address interconnection requirements for Generation facilities, Transmission facilities, and End-User facilities. For ease of use, the paragraph headings in this document use the requirements numbers in alignment with the FAC-001-3 standard. Except in cases where specifically delineated, the requirements within the document are applicable to Generation facility, Transmission facility, and End-User facility interconnections.

This document outlines Exelon Utilities specific technical requirements for interconnection within the BGE Transmission system in Maryland, the ComEd Transmission system in Illinois and Indiana, the PECO Transmission system in Pennsylvania, and the PHI Transmission system (ACE in New Jersey, DPL in both Delaware and Maryland, and Pepco in Maryland, Washington DC and Virginia). Requests for interconnection to the Exelon Utilities distribution systems are addressed in documentation that is available on the BGE website at [www.BGE.com](http://www.BGE.com); the ComEd website at [www.comed.com](http://www.comed.com); the PECO website at [www.peco.com](http://www.peco.com), PHI websites (ACE website at [www.atlanticcityelectric.com](http://www.atlanticcityelectric.com), the DPL website at [www.delmarva.com](http://www.delmarva.com), Pepco website at [www.pepco.com](http://www.pepco.com)), respectively.

For the remainder of this document the term “Exelon Utilities” includes BGE, ComEd, PECO, and PHI. Unless otherwise stated, all requirements apply to the interconnection of transmission, generation, and end-user (load serving) facilities to all Exelon Utilities Transmission System.

The Exelon Utilities are members of the PJM Interconnection LLC. The primary responsibility for the interconnection process and requirements is with PJM. The PJM Manual 14 series address the interconnection process, planning study requirements, and facility connection requirements specific to the PJM transmission system. All Exelon Utilities are active participants in the process. The PJM Manuals can be accessed via the PJM website at [www.pjm.com](http://www.pjm.com). Interconnection Requestors should review the PJM Manual for specific PJM requirements.

This document is intended to highlight the Exelon Utilities requirements and is not intended to fully replicate or to replace the PJM documentation. The scope of this document is limited to the description of the technical requirements of connecting facilities to the Exelon Utilities transmission system. It does not address any of the legal, contractual, or liability issues. These issues are normally addressed within the interconnection agreements as defined by the PJM process or each individual operating company tariff. In addition, the PJM Open Access Transmission Tariff (OATT) provides the Interconnection Services Agreement (ISA) that is utilized by Exelon Utilities and that includes several of the interconnection requirements. Normally all interconnection requests are directed to PJM. PJM Manuals and OATT are posted publicly on the PJM web site.

PJM Manual 14 series provides guidelines for developers of generation and merchant transmission projects through the planning up to the request for facility construction. Each Manual description can be found below:

- Manual 14A New Services Request Process – Guides the generation and/or transmission developers through the planning processes to interconnect to and operate in PJM markets.
- Manual 14B Regional Transmission Planning Process – Describes PJM's open and participatory process for planning baseline expansion facilities.
- Manual 14C Generation & Transmission Interconnection Facility Construction – Provides PJM process guidelines for the construction and integration of all RTEP projects, including generation and merchant transmission interconnections and Transmission Owner upgrades.
- Manual 14D Generator Operational Requirements– Focuses on generator responsibilities as signatories to the Operating Agreement of the PJM Interconnection and related market and operational requirements for connecting to the PJM system.
- Manual 14E Additional Information for Upgrade & Transmission Interconnection Projects Provides the specific requirements for interconnecting Merchant Transmission Facilities, proposing capability increases to specific Transmission Owner Facilities and making Upgrade Requests to obtain Incremental Auction Revenue Rights (IARRs) under PJM's Regional Transmission Expansion Planning Process. Additionally, it describes the various rights available and agreements required to complete the Transmission Interconnection or Upgrade planning process.
- Manual 14G Generation Interconnection Requests– Guides a Generation Interconnection customer through their application, study and agreement process including specific requirements and rights as a generator participating in PJM markets.

The PJM Regional Transmission Expansion Planning (RTEP) process is utilized for "utility to utility" initiated interconnections. Generator and Transmission interconnection inquiries are referred to PJM, and the PJM interconnection process is followed. PJM Manual 14A section on Specific Process Flow and Timeline provides a summary of the PJM interconnection process. PJM Manual 14A Section 1 states, "Entities requesting interconnection of a generating facility (including increases to the capacity of an existing generating unit or decommissioning of a generating unit) or requesting interconnection of a merchant transmission facility within the PJM RTO must do so within PJM's defined interconnection process." Impacts to the system are determined by a series of studies (results posted on the PJM web site), that include a Feasibility Study, System Impact Study, and Interconnection Facilities Study.

The information contained in this guide is not intended to capture each and every specific equipment and installation requirement. It represents a typical installation. The minimal requirements specified in this document may need to be modified to meet the needs of unique

installations. The intent of the requirements is to address all types of interconnections. As such, not all of the requirements will necessarily apply to all types of interconnections. Exelon Utilities reserves the right to determine which requirements apply to any specific requested interconnection. Specific requirements necessitated by the type of interconnection and the intended point of interconnection will be communicated to the Interconnection Requestor prior to the construction phase of the project.

### **RESPONSIBILITIES OF THE INTERCONNECTION REQUESTOR**

The Interconnection Requestor is responsible for designing, installing, operating, and maintaining its own equipment in accordance with Good Utility Practice(s), the National Electrical Code, the National Electrical Safety Code (NESC), North America Electric Reliability Corporation (NERC), ReliabilityFirst (RF), any applicable independent system operator, and all applicable laws and regulations. This includes installing, setting, and maintaining all protective devices necessary to protect the customer's facilities. It is also the responsibility of the party interconnecting to make appropriate arrangements with the Balancing Authority, PJM to ensure its Facilities are within the PJM metered boundaries. The requirements specified in this document are designed to only protect Exelon Utilities facilities and to maintain the reliability of the Bulk Electric System.

The interconnecting customer is responsible to coordinate with Exelon Utilities during the engineering / detailed design phase of the project in order to ensure coordination of protective relay devices.

### **GENERATOR INTERCONNECTION**

The Generation Interconnection Customer (GIC) is responsible for coordinating the design of its own generator step-up electrical facility with PJM and Exelon Utilities.

Exelon Utilities functional relay requirements will be provided to the GIC during the detailed design phase of the project, after the ISA has been executed. The information for the specific project will indicate the protective functions for which the GIC is to provide relays and related equipment. The GIC will indicate the specific relay type(s) and range proposed for each function. The GIC must also provide proposed current and potential transformer ratios, connections, and locations as related to the electrical one-line diagram.

If the ISA permits the option to build facilities, before proceeding with construction under the option to build, the GIC must furnish six sets of final design documents to PJM and Exelon Utilities for review and acceptance. GIC design documents (electrical prints, relay settings, etc.) will be reviewed by Exelon Utilities in coordination with PJM. Project delays due to untimely submittal of complete design documents are the responsibility of the GIC. These must be of good engineering quality and include the following:

- One-line diagram showing the connections between the generator(s) and the Exelon Utilities system
- Three-line diagrams showing current and potential circuits for protective relays

- Relay tripping and control schematic diagram
- Instruction books for relays

Additional engineering meetings may be necessary to discuss the design documents. If changes are necessary, the GIC must incorporate all changes and corrections and submit six sets of corrected prints to Exelon Utilities before proceeding with construction.

GIC's requiring retail service are required to complete a Service & Meter application. For BGE, end-user facility requests are submitted directly to BGE in accordance with the process described in the Baltimore Gas and Electric Retail Electric Service Tariff on the BGE website [www.bge.com](http://www.bge.com) under Rates & Tariffs for Electric Service. For ComEd, reference "Service Application for Commercial or Industrial Services (pdf)" in the "My Account>>My Service" section of the ComEd website ([www.comed.com](http://www.comed.com)). For PECO, the Service & Meter Application can be found in the Partners in Business section of the website ([www.peco.com](http://www.peco.com)).

For ACE within PHI, end-user facility requests are submitted directly to ACE in accordance with the process described in the Atlantic Electric Tariff on the ACE website ([www.atlanticcityelectric.com](http://www.atlanticcityelectric.com)) under Tariffs.

For DPL Delaware and DPL Maryland within PHI, end-user facility requests are submitted directly to DPL in accordance with the process described in the Delaware Tariff and DPL Maryland Tariff, respectively, on the DPL website ([www.delmarva.com](http://www.delmarva.com)) under Tariffs.

For Pepco District of Columbia and Pepco Maryland within PHI, end-user facility requests are submitted directly to Pepco in accordance with the process described in the Pepco District of Columbia Tariff and Pepco Maryland Tariff, respectively, on the Pepco website ([www.pepco.com](http://www.pepco.com)). Information such as the type of service requested and load levels expected are captured on the form.

## **FAC-001-3 REQUIREMENTS**

### **R1 – Facility Interconnection Requirements Document**

This document was written and posted for the purpose of complying with R1

### **R2 – Not applicable to this document – Generator Owner only**

### **R3 – Facility Interconnection Requirements Procedures**

#### **R3.1 – Procedures for coordinated studies**

Exelon Utilities are members of PJM Interconnection LLC. One of the many functions of PJM is to coordinate joint studies of new or materially modified facilities and their impacts on the interconnected transmission system. Exelon Utilities actively participate in this process. The process is described in the PJM Manual 14 series of documents which are available on the PJM website.

The PJM Manual 14A New Services Request Process includes attachments to the manual that define the data requirements for interconnection Feasibility and System Impact Studies. Generators and Transmission interconnection customers should refer to the manual for specific details. Data is to be submitted electronically via the PJM website (actual link as provided in the PJM Manual 14A).

The impact of the interconnection customer on the reliability of the interconnected transmission system shall be evaluated. Studies are performed by Exelon Utilities as requested by PJM, in conjunction with PJM and in accordance with established NERC, RF, PJM and jurisdiction-specific Exelon Utilities Transmission Planning Criteria.

The latest copy of the Exelon Utilities Transmission Planning Criteria for each jurisdiction is available on the PJM website under the Transmission Owner Planning Criteria tab on the Planning Criteria page. The Exelon Utilities Transmission Planning Criteria for each jurisdiction can be accessed by its respective company tab (BG&E, ComEd, PECO, or PHI).

### Generation and Merchant Transmission Interconnection Requests

All requests for Generation and Merchant Transmission facility interconnections must be submitted directly to PJM and processed through the PJM Interconnection process. The process by which requests for new Generation and Merchant Transmission Interconnection are submitted to PJM is described in PJM Manual 14A. This manual summarizes the guidelines, requirements, and procedures for Generation and Transmission interconnection, including Developer actions and PJM actions. Exelon Utilities evaluates the impact of proposed interconnections as directed by PJM.

For transmission interconnection, summary study results are published by PJM annually as part of the Regional Transmission Expansion Planning (RTEP) process. Interim results of studies are shared at periodic Transmission Expansion Advisory Committee (TEAC) and Subregional RTEP Committee meetings held by PJM in order to provide opportunity for stakeholder input. TEAC updates are publicly posted to the PJM website.

Interconnection planning studies are conducted to meet the criteria established within the NERC TPL series reliability standards, PJM manual 14B, and the Exelon Utilities Transmission Planning Criteria for each jurisdiction. Copies of the applicable planning standards are available on the NERC website and PJM website. Study results associated with individual generation and merchant transmission facility requests are posted by PJM to the PJM website.

### Transmission Interconnection – Transmission Owner to Transmission Owner

PJM performs annual studies to evaluate system reliability as described in PJM Manual 14B. As part of the evaluation process it may be determined that there is a need for additional system reliability support across multiple interconnected transmission owner facilities. Solutions to identified reliability issues are developed by the affected transmission owners in coordination with PJM. The study results and resultant solutions identified are documented in the PJM annual Regional Transmission Expansion Plan and posted to the PJM website.

### End-User Interconnection Requests

End-user requests are submitted directly to the local Exelon Utilities company as retail service requests. These requests are evaluated by Exelon Utilities to determine how the end-user will be connected and any system reliability impacts to the transmission system. Studies are primarily conducted to determine if there is available capacity at the interconnection point to accommodate the request. If additional system reinforcements are identified during the study, the results will be provided to the requestor and solutions will be proposed to address the issue. Once the end-user requestor agrees to proceed, Exelon Utilities will submit the reinforcements to the PJM Sub-Regional RTEP, and PJM will perform a no-harm study.

End-Users requesting to connect to the Exelon Utilities transmission system are required to complete a Service & Meter application. For BGE, end-user facility requests are submitted directly to BGE in accordance with the process described in the Baltimore Gas and Electric Retail Electric Service Tariff on the BGE website [www.bge.com](http://www.bge.com) under Rates & Tariffs for Electric Service. For ComEd, reference "Service Application for Commercial or Industrial Services (pdf)" in the "My Account>>My Service" section of the ComEd website ([www.comed.com](http://www.comed.com)). For PECO, the Service & Meter Application can be found in the Partners in Business section of the website ([www.peco.com](http://www.peco.com)).

For ACE within PHI, end-user facility requests are submitted directly to ACE in accordance with the process described in the Atlantic Electric Tariff on the ACE website ([www.atlanticcityelectric.com](http://www.atlanticcityelectric.com)) under Tariffs.

For DPL Delaware and DPL Maryland within PHI, end-user facility requests are submitted directly to DPL in accordance with the process described in the Delaware Tariff and DPL Maryland Tariff, respectively, on the DPL website ([www.delmarva.com](http://www.delmarva.com)) under Tariffs.

For Pepco District of Columbia and Pepco Maryland within PHI, end-user facility requests are submitted directly to Pepco in accordance with the process described in the Pepco District of Columbia Tariff and Pepco Maryland Tariff, respectively, on the Pepco website ([www.pepco.com](http://www.pepco.com)). Information such as the type of service requested and load levels expected are captured on the form.

### On-Going Reliability Analysis

Exelon Utilities participates in the PJM MOD-032 annual base case development process as a Transmission Owner in support of the annual PJM Regional Transmission Expansion Plan (RTEP) process and Multiregional Modeling Working Group (MMWG). PJM establishes schedules for its annual model updates and requests steady-state, dynamics, and short circuit modeling data in accordance with the PJM MOD-032 Model Data Requirements and Procedures.

Studies performed on an annual basis in line with the jurisdiction-specific Exelon Utilities Transmission Planning Criteria are documented and retained for internal Exelon Utilities use. Interconnections are evaluated to ensure that no Planning Criteria violations are identified.

GICs are responsible for the submittal of applicable data, as requested by PJM, in compliance with NERC reliability standards.



### On-Going Generator Interconnection Stability Studies

Severe disturbances on the power system can cause a synchronous generator to lose synchronism with the power system. A large generator operating in this unstable manner can create large power and voltage fluctuations and can severely stress the generator and power system equipment. Damage could result to the GIC equipment, the Exelon Utilities transmission system, and other interconnected entity facilities. The stability studies will therefore verify that the GIC does not become unstable and that it does not cause neighboring generation to become unstable.

The following procedures will be used to ensure that the interconnection design provides for an adequate stability margin.

PJM in conjunction with Exelon Utilities will perform stability analysis in order to verify that the generator installation meets PJM and Exelon Utilities criteria. In this criterion, faults that could credibly occur near the generator will be analyzed. Scenarios include, but are not limited to, three-phase faults with failed breakers and three-phase faults during maintenance outages. If the GIC owned generator or other nearby generation loses synchronism for a scenario, additional system upgrades may be necessary to prevent the generator from becoming unstable. PJM and Exelon Utilities will complete the initial stability analysis of the interconnections and will identify equipment requirements and any system upgrades required for the interconnection design.

Stability analysis performed by PJM and Exelon Utilities will not evaluate the risk to the GIC's equipment due to unstable operation of its own generator. It is the responsibility of the GIC to assess these risks and protect their equipment accordingly.

If subsequent generation is added to the PJM system near the GIC's interconnection, it is PJM's and Exelon Utilities' responsibility to assess the risks of these changes. Any subsequent generation added must follow the PJM Interconnection process described in PJM Manual 14A. If necessary, PJM and Exelon Utilities will re-verify that the generator installation meets PJM requirements in addition to both interconnection and Transmission Planning Criteria requirements for the jurisdiction-specific Exelon Utility.

### **R3.2 – Procedures for Notification**

Any additions or modifications to existing facilities that have the potential to affect an interconnection require the customer to notify their Exelon Utilities point of contact as soon as feasible. Exelon Utilities will assess the potential impact of the modifications and contact the appropriate affected parties. The significance of any impact has the potential to vary over a broad range. Changes that could affect the operating limits on the interconnected system may require engineering studies and the involvement of PJM. Changes that modify power output must follow the requirements of PJM Manual 14A. The most significant impacts will trigger the processes described in the previous section (R.2.1.1). Less significant changes that still impact reliability will be forwarded to PJM for additional evaluation.

Any surveillance/testing activities of equipment located in, or associated with, the Switchyard that are performed by the interconnected customer that result in abnormal, irregular, or unusual conditions detected during such activities shall be promptly reported by the interconnected customer to the appropriate Transmission Operators (BGE, ComEd, PECO, or PHI).

Notification of major/minor alarms received, and protective relay targets (mechanical flags and indicating lights) detected, at the facility concerning the Switchyard, shall be reported by the interconnected customer to the appropriate Transmission Operators (BGE, ComEd, PECO, or PHI) by telephone as soon as identified.

### **R3.3 – Procedures for confirming Balancing Authority Area**

All requests for Generation and Merchant Transmission facility interconnections must be submitted directly to PJM and processed through the PJM New Services Request Process. The process by which requests for new or materially modified existing interconnections are submitted to PJM is described in PJM Open Access Transmission Tariff (OATT), rules around the PJM Regional Transmission Expansion Process Manual 14B, and the New Services Request Process Manual 14A. PJM assesses facilities within its Balancing Authority Area metered boundaries through the requirements in its OATT, Manual 14A, and 14B.

The preamble to the PJM Open Access Transmission Tariff (OATT) states, in part, that an Interconnection Customer that proposes to interconnect to the Transmission System in the PJM Region, shall request interconnection with the Transmission System pursuant to, and shall comply with, the terms, conditions, and procedures set forth in Part IV of the Tariff. Subpart G of Part IV of the Tariff and related portions of the PJM Manuals apply to Interconnection Requests. The PJM OATT goes on to state that “Interconnection Customer” shall mean a Generation Interconnection Customer and/or a Transmission Interconnection Customer.

As a result, all new or materially modified facilities that seek interconnection to, or upgrade facilities on, the PJM system (Balancing Authority) must come through the New Services Queue. All such approved projects are given an Interconnection Service Agreement and/or an Upgrade Construction Service Agreement (ISA and UCSA, respectively) and this documentation is sent to FERC for their review and approval.

Based on PJM Compliance Bulletin CB028, a PJM issued ISA/UCSA is FERC approved evidence to demonstrate new or materially modified facilities are within the PJM Balancing Authority Area’s metered boundaries.

End-user facility interconnection requests for interconnection within the Exelon Utilities footprint are required to directly submit a Service & Meter application as documented in R3.1 End-User Interconnection Requests section of this document. The Service & Meter application process includes identifying the point of interconnection through coordination between the End-user facility customer and Exelon Utilities.

### **R4 – Not applicable to this document – Generator Owner only**

## **OTHER REQUIREMENTS OF INTERCONNECTION REQUESTOR**

### **1. End-Use Customer Voltage Level and MW and MVAR Capacity or Demand**

After the End-Use Customer supplies PJM/Exelon Utilities with the approximate geographic location and the desired megawatt (MW) and megavolt-amp reactive (MVAR) capacities at the point of interconnection, PJM/Exelon Utilities will exercise engineering judgment and the results of engineering studies to determine appropriate voltage levels, interconnection points, and system capabilities for the point of interconnection, since the most practical voltage and interconnection points are site and project specific.

### **2. Breaker Duty - Surge Protection**

All facilities and equipment must equal or exceed the fault duty capability necessary to meet system short-circuit requirements as determined through short-circuit analyses and should fully comply with the latest American National Standards Institute (ANSI)/Institute for Electrical and Electronics Engineers (IEEE) C37 collection of standards for circuit breakers, switchgear, substations, and fuses.

In order to maintain transmission reliability, each fault-interrupting device must be rated for full fault-interrupting capability to satisfy the short-circuit level requirements at the point of interconnection. Full fault-interrupting capability is per the latest IEEE C37 and C57 collections of standards. As a general rule, neither party should depend on the other for the protection of their respective equipment.

### **3. System Protection and Coordination**

Protective relaying systems and associated communications systems for all facility interconnections shall be planned, designed, constructed, and maintained in accordance with applicable NERC, RF, and PJM standards. Utility grade protective relays and fault clearing systems are to be provided on the interconnected power system. All protective relays shall meet or exceed ANSI/IEEE Standard C37.90. Adjoining power systems may share a common zone of protection between two parties. The design must provide coordination of speed and sensitivity in order to maintain power system security, stability, and reliability.

The protection system (protective relays, associated communication systems, voltage and current sensing devices, station batteries and DC control circuitry) arrangement selected by the customer must be compatible with the protections system used by Exelon Utilities to protect the transmission grid. Compatible relaying equipment must be used for a given zone of protection. Compatibility includes protection application, redundancy, operating speed, communication type, and communication medium.

A power source for tripping and control must be provided for the protection system by a DC storage battery. The battery is to be sized with enough capacity to operate all tripping devices

after eight hours without a charger, per IEEE standards. An under-voltage alarm must be provided for remote monitoring by the facilities owners, who shall take immediate action to restore power to the protective equipment.

Mechanical and electrical logic and interlocking mechanisms are required between interconnected facilities to ensure safe and reliable operation. These include, but are not limited to, breaker and switch auxiliary contacts, synch-check relays, and physical locking devices.

The facility owner (generator, transmission, end-user) is responsible for providing a protection system that will protect its equipment against disturbances on Exelon Utilities system and minimize the effects of disturbances from its facilities on Exelon Utilities equipment and transmission system. Entities connecting to the Exelon Utilities transmission system shall investigate and keep a log of all protective relay actions and misoperations, as required by NERC, RF and PJM. In addition, the interconnecting entities must have a maintenance program for their protection systems in accordance with NERC. Documentation of the protection maintenance program shall be supplied to Exelon Utilities, PJM, RF, and NERC upon request. As outlined in the maintenance program, test reports are to be made available for review by Exelon Utilities. At intervals described in the documented maintenance program and following any apparent malfunction of the protection equipment, the Interconnecting Customer shall perform both calibration and functional trip tests of its protection equipment as outlined by NERC.

The system protection system plan and scheme must be approved by Exelon Utilities and meet the current technical standards of the utility.

### Generator Protection Requirements

GIC must provide detailed protection schematics to Exelon Utilities to allow a review of the compatibility and coordination with the transmission system. Generators connecting to the Exelon Utilities transmission system are responsible for protecting those facilities from electrical faults and other hazardous conditions. Generator interconnections must be equipped with circuit breakers or other appropriate interrupting devices to protect those facilities. The generator owner must provide and own the primary circuit breaker or other interrupting device that protects the facility and disconnects it from the Exelon Utilities transmission system. The primary purpose of this interrupting device is to protect the generating plant facility.

Synchronous or inverter-based generation resources connected to the Exelon Utilities transmission system shall be able to withstand certain temporary excursions in voltage, frequency, and reactive and real power output without tripping or entering momentary cessation. A System Impact Study will determine if the generator will trip during temporary excursions. Generation must ride through temporary excursions to support the grid and avoid cascading events.

It is recognized that certain circumstances may exist that necessitate the imposition of performance criteria that is considered more stringent than the default criteria specified above. Such circumstances shall be identified during the conduct of the System Impact Study or operational study for each particular generator.

### Transmission Protection Requirements

All transmission power systems shall have a dual protective relaying scheme that provides both primary and backup coverage of the remote bus. Communications-aided tripping through the use of a dedicated communications channel may be required based on system stability determination. Communications redundancy may be required depending on critical clearing time. A transfer trip may be required for backup protection and islanding schemes.

Backup protective systems should provide additional coverage for breaker and relay failure outside the primary zone. Specific breaker failure protection schemes shall be applied as required to meet NERC requirements, and, where local/remote backup does not provide adequate sensitivity or speed, specific relay failure backup shall also be provided. Backup systems shall operate for failures on either side of an interconnection point. Time and sensitivity coordination must be maintained to prevent misoperations.

Fiber optics is the standard means of relay communications; however, microwave and power line carrier may also be used in limited circumstances.

Each fault-interrupting device must be rated for full fault-interrupting capability to satisfy the short-circuit level requirements at the point of interconnection. Neither party shall depend on the other for the protection of their respective equipment.

#### **4. Metering and Telecommunications**

Metered data shall be telemetered to a location designated by PJM and location as designated by Exelon Utilities unless alternate satisfactory telemetered locations are agreed to by the Exelon Utilities and Interconnection Customer.

Interconnecting Customers that will be a market participant shall install metering that shall be of sufficient quality to meet the requirements as defined by PJM in the PJM Manuals 14A, 14C, 14D and 14G.

Periodic operator tests of protective relay communication channels shall be conducted by the Interconnected Customer in accordance with written guidelines furnished by Exelon Utilities and as reasonably requested by Exelon Utilities in coordination with Exelon Utilities operators at the remote end terminals of transmission lines. The Interconnected Customer shall record all test, alarm and relay target data as required and notify Exelon Utilities of abnormalities as necessary. Sequence of event recording shall be made available to Exelon Utilities upon request.

The metering and telecommunications plan must be approved by Exelon Utilities and meet the current technical standards of the utility.

#### Revenue Metering Guidelines

For the purposes of this document, revenue metering shall refer to the meter or meters used for billing purposes and the associated current transformers and potential transformers (collectively

known as “instrument transformers”), communications equipment, and wiring between these devices. The basic configuration consists of directional revenue grade metering (import and export) at each point of interconnection with the Exelon Utilities system. Additional separate revenue metering for the gross output of the generation and for auxiliary retail loads may be required, depending on the generation capacity, telemetry requirements, applicable contractual provisions and associated tariffs. All generation and auxiliary retail metering shall have the ability to connect to the Exelon Utilities Automated Meter Reading (AMR) system.

Before the purchase or fabrication of revenue metering equipment, four sets of each of the following information must be submitted to Exelon Utilities for review and acceptance:

- Overall Electrical Single-Line Drawing, showing location of revenue metering equipment.
- Switchgear Single-Line Drawing, showing location of revenue metering transformer compartment.
- Physical Metering Transformer Compartment drawing, showing the layout of revenue metering current transformers and potential transformers.
- If the installation utilizes a stand-alone current transformer cabinet, the manufacturer’s drawing, showing the catalog number and address at which, its use is intended.
- Estimated generation capacity and auxiliary retail loads.

## **5. Grounding and Safety Issues**

A safe grounding design must accomplish two basic functions:

- Ensure that a person in the vicinity of grounded structures and facilities is not exposed to critical levels of step or touch potential, and
- Provide a path for electric currents into the earth under normal and fault conditions without exceeding any operating and equipment limits or adversely affecting the continuity of service.

Accordingly, each electrical facility must have a grounding system or grid that solidly grounds all metallic structures and equipment in accordance with standards outlined in ANSI/IEEE 80, IEEE Guide for Safety in AC Substation Grounding, ANSI/IEEE C2, National Electrical Safety Code (NESC).

Testing must be performed to ensure safe step and touch potential parameters have been met in accordance with IEEE 80.

When various switching devices are opened on an energized circuit, its ground reference may be lost if all sources are not effectively grounded. This situation may cause over voltages that can affect personnel safety and damage equipment. This is especially true when one phase becomes short-circuited to ground. Therefore, the interconnected transmission power system is to be effectively grounded from all sources. This is defined as  $X0/X1 < 3$  and  $R0/X1 < 1$ . Interconnected generators should provide for effective system grounding of the high-side transmission equipment by means of a grounded high-voltage generation step-up transformer.

The grounding system plan must be approved by Exelon Utilities and meet the current technical standards of the utility.

Safety is of utmost importance. Strict adherence to established switching, Lock Out/Tag Out procedures, and grounding procedures is required at all times for the safety of personnel. Any work carried out within a facility shall be performed in accordance with all applicable laws, rules, and regulations and in compliance with Occupational Safety and Health Administration (OSHA), NESC, and good utility practice. Automatic and manual disconnect devices are to be provided as a means of removing all sources of current to any particular element of the power system. Only trained operators are to perform switching functions within a facility under the direction of the responsible dispatcher or designated person as outlined in the NESC.

## **6. Insulation and Insulation Coordination**

Insulation coordination is the selection of insulation strength. Insulation coordination must be done properly to ensure electric system reliability and personnel safety. Basic switching surge levels, surge arrester, conductor spacing and gap application, substation and transmission line insulation strength, protection, and shielding shall be documented and submitted for evaluation as part of the interconnection plan.

Interconnection facilities to be constructed in areas with salt spray contamination or other type of contamination shall be properly designed to meet or exceed the performance of facilities not in a contamination area with regard to contamination-caused outages. Equipment basic impulse surge levels (BIL) shielding and surge protection shall be designed to meet the latest IEEE C62 standards, along with Exelon Utilities standards.

## **7. Voltage, Reactive Power, and Power Factor Control**

### Generator Interconnection

PJM is responsible for ensuring the stability and reliability of its Bulk Electric System. In turn, all GICs are responsible for operating their units in a stable manner while those units are connected to the Exelon Utilities system. Generator excitation and prime mover controls are key elements in ensuring electric system stability and reliability. To meet its responsibility, PJM must have the ability to establish voltage and governor control requirements for all generators connected to its system. These requirements may vary depending on the location, size, and type of generation installed.

GICs are required with oversight by PJM to follow the current NERC and RF standards and guides for generator operation, protection, and control.

- All synchronous generators connected to the interconnected transmission systems shall be operated with their excitation system in the automatic voltage control mode unless approved otherwise by PJM.
- PJM/Exelon Utilities shall be notified any time a voltage regulator is taken out of service.

- Generators shall maintain a network voltage or reactive power output as required by Exelon Utilities, with governance by PJM, within the reactive capability of the units. Generator step-up and auxiliary transformer shall have their tap settings coordinated with electric system voltage requirements.
- Temporary excursions in voltage, frequency, and real and reactive power output that a generator shall be able to sustain shall be defined and coordinated on a regional basis.
- Voltage regulator controls and limit functions (such as over and under excitation and volts/hertz limiters) shall coordinate with the generator's short duration capabilities and protective relays.
- Prime mover controls (governors) shall operate with appropriate speed/load characteristics to regulate frequency.

Power factor requirements for new generator interconnection requests and increase to existing generators are documented in PJM Manual 14G Generation Interconnection Requests in the Generator Power Factor Requirements section.

Specific requirements for voltage regulators, power system stabilizers, governor controls, and remote control and telemetry of such devices will be determined during the System Impact Study. The specific requirements for a generator will become part of the Interconnection Service Agreement. (PJM Manual 14A).

### Transmission Facilities

The transmission system must be capable of moving electric power from areas of generation to areas of load under a wide variety of expected system conditions. Adequate reactive power supplies are of paramount importance to the capability of the transmission system to reliably support a wide variety of transfers. Transmission facilities must be designed to minimize excessively high voltages during light transmission loading conditions yet have adequate reactive supplies to support system voltage during heavy transmission loading conditions.

### End-User Facilities

Exelon Utilities will supply End-User facilities within the voltage requirements as stated in the applicable state tariffs. End-User facilities connected directly to the transmission system should plan and design their systems to operate at close to unity power factor to minimize the reactive power burden on the transmission system.

## **8. Power Quality Impacts**

At no time shall the operation of the Interconnecting Customer facility, including associated generators or any of their auxiliary devices as applicable, result in an electrical output in which harmonic distortion exceeds the recommended limits contained in IEEE Standard 519, which defines voltage waveform and harmonic content.

## **9. Equipment Ratings**



All circuit breakers and other fault-interrupting devices shall be capable of safely interrupting fault currents for any fault they may be required to interrupt. Application of circuit breakers shall be in accordance with the ANSI/IEEE C37 collection of standards.

All current-carrying equipment and devices shall be designed to carry the maximum loads that are predicted and used in load flow analysis tested against all applicable NERC standards, PJM and jurisdiction-specific Exelon Utilities Transmission Planning Criteria. Loads exceeding nameplate or normal design capacities are acceptable only when allowed by manufacturers' design documentation or standard industry practice.

Equipment BILs, shielding, and surge protective device application must meet requirements as determined by the latest IEEE C62 standards. Exelon Utilities will provide the BIL for the system in the interconnection area. Also, equipment must meet all applicable ANSI/IEEE standards and specifications communicated by PJM/Exelon Utilities.

## **10. Synchronizing of Facilities**

The Interconnection Customer shall obtain PJM's approval prior to either synchronizing with the transmission system or energizing, as applicable per the determination of PJM, the Customer Facility or, except in an emergency condition, disconnecting the Customer Facility from the transmission system, and shall coordinate such synchronizations, energizations, and disconnections with Exelon Utilities Transmission System Operations (TSO).

Protection personnel from Exelon Utilities and the Interconnecting Customer jointly develop protection schemes for inter-tie lines. Protective scheme prints, settings and tests are jointly shared and reviewed for coordination and fault-modeling information is exchanged.

If necessary, synchronization points/locations shall be noted on the project plans or relay plans developed during the detailed design/construction phase of the project. The synchronization points are defined as locations that have the capability and are the preferred locations for synchronization for paralleling a synchronous generator or if needed during a recovery from a black start or islanding event. In addition to manual synchronization points, "synchro-check" relays shall also be noted on the project plans or relay plans.

Additional guidance regarding synchronization of facilities is documented in PJM Manual 14A.

The Interconnection Customer shall assume all responsibility for properly synchronizing its generation for parallel operation with all Exelon Utilities Transmission System. New generators shall have a method of synchronizing so that Exelon Utilities will not have to operate station breakers for generation operation. Isolation between Exelon Utilities Transmission System and the Interconnection Customer's system should be accomplished at a minimum with a single circuit breaker.

## **11. Maintenance Coordination**

The interconnection parties agree to confer regularly to coordinate the planning, scheduling and performance of preventive and corrective maintenance on the Customer Facility, the Customer Interconnection Facilities and any attachment facilities owned by Exelon Utilities.

On occasion, Exelon Utilities must remove its lines from service for maintenance. These planned outages are for purposes such as: testing relays, rearranging, modifying or constructing lines, and maintaining lines or station equipment. The Interconnected Customer, Exelon Utilities and PJM will coordinate these planned outages.

### Generator Interconnection

On occasion, the GIC may not be allowed to operate in parallel with the Exelon Utilities T&D system or, in the case of a GIC with multiple interconnection points, may be permitted to operate only in parallel with specific lines so Exelon Utilities can perform “Liveline Maintenance” on the facilities serving the GIC. The GIC, Exelon Utilities (and possibly PJM) will coordinate with these conditions and requests.

## **12. Operational Issues (Abnormal Frequency and Voltages)**

PJM is the Transmission Operator for the Exelon Utilities transmission systems. The interconnection will be operated consistent with PJM requirements and procedures. Specific transmission conditions and procedures for operation of Transmission Facilities within PJM are found in Manual 3 Transmission Operations on the PJM website ([www.pjm.com](http://www.pjm.com)).

### Generator Interconnection

The Transmission System is designed to automatically activate a load-shed program as required by RF in the event of an under-frequency system disturbance. A GIC shall implement under-frequency and over-frequency relay set points for the GIC as required by RF to ensure ‘ride through’ capability of the Transmission System. The GIC Facility is to stay connected to and synchronized with the transmission system during system disturbances within a range of under-frequency and over-frequency conditions, in accordance with Good Utility Practice. The response of a GIC’s Facility to frequency deviations of predetermined magnitudes; both under-frequency and over-frequency deviations are studied and coordinated with PJM in accordance with Good Utility Practice. Additional information is found in PJM Manual 14D.

## **13. Inspection Requirements for Existing or New Facilities**

Each party to the interconnection agreement shall perform routine inspection and testing of its facilities and equipment in accordance with good utility practice and regulatory requirements to ensure the continued interconnection of the facilities with Exelon Utilities transmission system.

Each party shall, at its own expense, have the right to observe the testing of any of the other party’s facilities and equipment whose performance may reasonably be expected to affect the reliability of the observing parties’ facilities and equipment. Each party shall notify the other party in advance of facility and equipment testing, and the other party may have a representative attend and be present during such testing. If a party observes any deficiencies or defects on or

becomes aware of a lack of scheduled maintenance and testing with respect to the other party's facilities and equipment that might reasonably be expected to adversely affect the observing party's facilities and equipment, the observing party shall provide notice to the other party that is prompt under the circumstance, and the other party shall make any corrections required in accordance with good utility practices and as required by regulatory agencies.

#### Generator – Inspection, Testing and Authorization

Exelon Utilities will review, in collaboration with PJM, the general design of the protection scheme for an interconnection site. The GIC is responsible for the design of protection that involves the GIC facilities.

The GIC must furnish to Exelon Utilities the proposed settings for relays specified. If requested, Exelon Utilities will provide system data needed to determine the relay settings. PJM Manual 21, Rules and Procedures for Determination of Generating Capacity provide the procedure for generator capability and the testing criteria. Exelon Utilities has the right to witness the tests and inspect before energizing the equipment. The GIC must notify PJM and Exelon Utilities 14 days before energizing the equipment. The GIC is responsible for providing qualified personnel who will complete all required tests. Exelon Utilities will not perform any of the testing unless contracted to do so.

The GIC is responsible for ensuring that all circuit breakers, controls, relays and other protective devices are adjusted and functioning correctly. The GIC shall provide test equipment and qualified personnel to perform the required tests. PJM, per Manual 21, will provide a list of proposed tests to be witnessed.

The witness test list for a given site will be the ultimate governing document. GIC representatives shall work with the Exelon Utilities project team representatives to schedule resources for witness testing and review of testing documentation. Four sets of approved as-built documentation must be provided to Exelon Utilities. Project delays caused by untimely submittal of approved as-built documentation are the responsibility of the GIC.

Initial energizing of high voltage circuits will not be allowed until the site design has been approved and all requirements of the PJM Tariff have been satisfied. Energizing equipment without required approval may result in disconnection from the Exelon Utilities system.

#### GIC Maintenance of Equipment

The GIC must provide Exelon Utilities or PJM with calibration and functional test data for the associated equipment upon request. The GIC must also follow any applicable NERC, RF, or PJM guides for maintenance and testing.

### **14. Communications and Procedures During Normal and Emergency Operating Conditions**

Complete, precise, and timely communication is an essential element for maintaining reliability and security of a power system. Under normal operating conditions, the major link of

communication with various interconnects shall be by telephone lines. Exelon Utilities and the Interconnected Customer shall maintain communications which shall include, but not be limited to:

- system paralleling or separation
- scheduled or unscheduled shutdowns
- equipment clearances
- periodic load reports
- maintenance schedules
- tagging of interconnection interrupting devices
- meter tests
- relay tests
- billing
- other routine communication

In case of emergency or abnormal operating conditions, various communication channels may be used depending on the interconnect category. Emergency telephone numbers should be agreed upon by both parties prior to the actual connect date.

Each Interconnection Party shall notify the other parties promptly when it becomes aware of an emergency condition that may reasonably be expected to affect operation of the Customer Facility, the Customer Interconnection Facilities, the Exelon Utilities Interconnection Facilities, or the transmission system.

#### Interconnection Customer Obligations

The Interconnection Customer shall install and maintain satisfactory operating communications with PJM's system dispatcher or its other designated representative and with Exelon Utilities system operators. The Interconnection Customer shall provide standard voice line, dedicated voice line and facsimile communications at its Customer Facility control room through use of the public telephone system. The Interconnection Customer also shall provide and maintain backup communication links with both PJM and Exelon Utilities for use during abnormal conditions as specified by PJM and Exelon Utilities, respectively. The Interconnection Customer further shall provide the dedicated data circuit(s) necessary to provide Interconnection Customer data to the PJM and Exelon Utilities as necessary to conform with applicable technical requirements and standards.

#### Transmission Interconnection

Transmission service and energy scheduling are arranged between the customer and PJM by using the PJM Power Meter applications.

Each Interconnecting Customer will be required to provide a contact name and method of communication within the Interconnecting Customer's operation to Exelon Utilities Transmission System Operations Dispatcher.

#### Generator Interconnection

At the GIC's expense, the GIC shall maintain satisfactory operating communications with Exelon Utilities Transmission System Dispatcher or representative, as designated by the Exelon Utilities. The GIC shall provide standard voice line, dedicated voice line and facsimile communications at its facility control room through use of the public telephone system. The GIC shall also provide the dedicated data circuit(s) necessary to provide necessary generator data to Exelon Utilities. The data circuit(s) shall extend from the Generator Facility to a location(s) specified by Exelon Utilities. Any required maintenance of such communications equipment shall be performed at the GIC's expense.

The GIC's operator is required to communicate to the Exelon Utilities Transmission System Operators their intention to perform any operational step(s) that could have an influence on the transmission system. The GIC's operator is required to follow PJM and Exelon Utilities instruction during emergency conditions (e.g. restoration). Participation in drills conducted by PJM or Exelon Utilities is required upon request.

Advance Notification of GIC Facilitated Equipment Status Changes

The GIC's operator is required to communicate to the Exelon Utilities Transmission System Dispatcher their intention to perform any operational step(s) that could have an influence on the transmission system. This notification is to be made prior to actually performing the configuration changes to their on-site equipment. This advance notification requirement also applies to 'bringing a generator on' or 'taking a generator off' the bus. Whenever possible, as in the case of switching activities related to scheduled maintenance work, the advance notice to Exelon Utilities should be done a few days prior to the day of the actual switching activities. Scheduled maintenance work must be coordinated with Exelon Utilities to meet PJM advanced outage notification requirements addressed in the PJM manuals for generators or transmission facilities.

End-User / Generator Interconnection

Exelon Utilities has established Account Managers for its major end-use and generator customers. Account Managers maintain communication with these customers during normal situations by mail, telephones, e-mails, seminars, brochures, etc. as appropriate. Exelon Utilities Customer Service Centers are available 24 hours a day to all customers via toll free numbers. In an emergency situation, the Exelon Utilities System Operation Center will initiate communications with its internal operating entities including Account Managers. Account Managers provide to the Customer Service Center a list of key customers to be called. Also, the Account Manager may be contacted for additional information.

**REVIEW/REVISION HISTORY**

Rev #	Rev Date	Purpose
0	3/15/2010	Consolidate ComEd/PECO transmission interconnection requirements into a single document. Support compliance to NERC standard FAC-001-0 Facility Connection Requirements.

1	05/09/2014	Incorporate changes due to FAC-001-1 approval. Updated Reference Section – Service and Meter Application information. Added supporting ComEd only document to Reference Section.
2	10/01/2015	Incorporate changes due to FAC-001-2 approval. Updated to incorporate the Exelon Utilities (BG&E, ComEd and PECO) methodology.
3	12/01/2015	Incorporate edits to align with numbering of FAC-001-2. Added Section 4, “Other Guidance” to provide additional information applicable to interconnection projects.
4	11/20/2017	Incorporate PHI as part of Exelon Utilities.
5	11/30/2018	Incorporate changes due to FAC-001-3 approval. Updated Responsibilities of the Interconnection Requestor and added section R3.3 incorporating language from PJM Compliance Bulletin CB028 to ensure that the requestor’s new or modified facilities are within PJM’s metered boundaries.
6	1/1/2021	Updated Transmission Facility Connection Requirements section as well as the Responsibilities of the Interconnection Requestor section.

**GLOSSARY/DEFINITIONS**

FERC – Federal Energy Regulatory Commission

Good Utility Practice – shall mean any of the applicable practices, methods and acts:

- Required by FERC, NERC, RF, PJM, or the successor of any of them, whether or not the party whose conduct is at issue is a member thereof,
- Required by applicable law or regulation,
- Otherwise engaged in or approved by a significant portion of the electric utility industry during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in the light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practice, reliability, safety and expedition. Good Utility Practice is not intended to be limited to optimum practice, method or act to the exclusion of all others, but rather is intended to include acceptable practices, methods, or acts generally accepted in the region.

IEEE - Institute of Electrical and Electronics Engineers

NERC – North American Electric Reliability Corporation

NESC – National Electric Safety Code

PJM – Independent system operator of the PJM control area pursuant to the PJM Operating Agreement and the PJM Tariff

RF – ReliabilityFirst Corporation

Transmission System – Facilities owned, controlled, or operated by the Regional Transmission Owners, for the purposes of providing transmission service, including services under the PJM Tariff and Interconnection Service.

Transmission Customer – Any entity requesting or utilizing transmission service on the PJM Transmission System.

## **REFERENCES**

Exelon Utilities Transmission Planning Criteria – located on the PJM website @[www.pjm.com](http://www.pjm.com) in the Planning section of the website, jurisdiction-specific criteria available from the BGE, ComEd, PECO or PHI tabs

IEEE Standards (available from IEEE – information @[www.ieee.org](http://www.ieee.org))

NERC Reliability Standards (located on the NERC website @[www.nerc.com](http://www.nerc.com))

PJM Documents (located on the PJM website @[www.pjm.com](http://www.pjm.com)):

- Manual 03 – Transmission Operations
- Manual 14A – New Services Request Process
- Manual 14B – PJM Region Transmission Planning Process
- Manual 14C – Generation and Transmission Interconnection Facility Construction
- Manual 14D – Generator Operational Requirements
- Manual 14E – Additional Information for Upgrade & Transmission Interconnection Projects
- Manual 14G – Generator Interconnection Requests
- Manual 21 – Rules and Procedures for Determination of Generating Capacity
- Regional Transmission Expansion Planning (RTEP) annual reports
- Generator and Merchant Transmission Interconnection Feasibility Study, System Impact Study, Interconnection Facilities Study, Interconnection Services Agreements, and Construction Service Agreement
- Transmission Owner Facility Connection Requirements

RF Reliability Standards (located on the ReliabilityFirst website @[www.rfirst.org](http://www.rfirst.org))

ComEd Interconnection Guidelines for Generators Greater than 20MW (located on the PJM website @[www.pjm.com](http://www.pjm.com) and ComEd website @[www.comed.com](http://www.comed.com) (ComEd Only)

Technical Considerations Covering Parallel Operations of Customer Owned Generation (located on the PJM website and on the PHI website @[www.pepcoholdings.com](http://www.pepcoholdings.com)) (PHI Only)

Service and Meter Application

- BGE – under My Account Electric Service Rates and Tariffs section of the BGE website @[www.bge.com](http://www.bge.com)

- ComEd – under the “My Account>>My Service” section of the ComEd website @www.comed.com
- PECO – under the Business Customers tab in the New Business Services section of the PECO website @www.peco.com
- PHI
  - ACE – under the Tariff tab within the Choices and Rates subsection of either My Home or My Business sections
  - DPL – under the Tariff tab within the Choices and Rates subsection of either My Home or My Business sections
  - Pepco – under the Tariff tab within the Choices and Rates subsection of either My Home or My Business sections