Exelon Energy Delivery Interconnection Guidelines for Generators Greater than 2 MVA and Less than or equal to 20 MVA
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Introduction and Scope

This guide is for Generation Interconnection Customers (GICs) who are evaluating, planning, or operating generation in parallel with the Exelon Energy Delivery (EED) system. It will provide technical information and requirements for acceptable interconnection with the EED system. This guide describes relaying required to protect the EED System only. It is the customer’s responsibility to adequately protect his equipment including the generator.

For customers looking to sell power in the PJM energy market, PJM will have involvement in the generator interconnection process. Also, PJM will be involved with any generators that are connected either directly or through a local transformer to the transmission system at the point of common coupling. When entering the PJM energy market the generator must also comply with PJM’s “Manual 14B Attachment H or H1”. The PJM guidelines are very similar to the EED guidelines and will not create an additional layer of protection. Customers who will not export power only need to comply with this guide and references to PJM in this guide can be ignored. Also “Qualified Facilities” in Illinois (such as landfills) do not need to follow the PJM guidelines as the generated power is sold directly to ComEd.

This guide only provides the technical requirements to interconnect a GIC. Small generator interconnection procedures and agreements are covered in separate documents.

DEFINITIONS

“Generation Interconnection Customer (GIC)”: An entity that submits an Interconnection Request to interconnect a new generation facility or to increase the capacity of any existing generation facility interconnected with the EED System.

“T&D System” refers to the Exelon Energy Delivery Transmission and Distribution System. Transmission generally referencing lines with a voltage of 69kV and greater and distribution referencing lines with voltages less than 69kV. NOTE: Both ComEd and PECO operate a 34kV sub-transmission system, which is relayed and operated differently from 69kV distribution systems.

“EED System” as used in this document refers to facilities owned, controlled, or operated by Exelon Energy Delivery.

“ISA” in this document is the tri-party Interconnection Service Agreement between PJM, EED and the GIC.

“CSA” in this document is the tri-party Construction Service Agreement between PJM, EED and the GIC.

“Parallel Generation” refers to generation directly interconnected to the EED T&D System for periods in excess of those described in Momentary Parallel Generation below. Parallel generation will be required to install the appropriate EED relay protection described in this guide.
“Momentary Parallel Generation” refers to generation connected for short periods of time during a transition from the EED System to the customer's local electric power system and on return to the EED System. Generation that is connected to the EED System for 10 cycles or less is considered Momentary Parallel Generation. (See the section on Momentary Parallel Generation in this guide.)

EED “Distribution Line” or “Feeder” consists of the medium voltage conductors and equipment emanating from an EED substation that serves customers through distribution transformers. In most cases these feeders are radial (meaning they have a source at only one end), but may also be primary networked, where the line has two or more sources forming a primary network.

“Line/Feeder Section” is a portion of a line or feeder bounded by automatic protective equipment (such as circuit breakers, reclosers, sectionalizers, and fuses) or the end of the line. This protective equipment effectively splits the feeder into smaller sections. If no additional protective equipment is installed between the generator and the substation the line section could be the entire line. Minimum feeder loads will be based upon the smaller “line section” if this type of equipment exists on the feeder. For example, the minimum line load on a feeder is 2000 kVA, but a recloser has been installed at the load center of the feeder. If a customer installs a generator on the 2nd half of the feeder behind the recloser the minimum “Line Section” load is 1000 kVA and this will be used to determine the protection plan required.

“PJM” is the Regional Transmission Operator (RTO) for both ComEd and PECO. PJM also markets energy produced within the PJM territory. From the standpoint of both operating and marketing energy, PJM has an interest in generators that export power on to portions of the grid under its control.

“Station Power” shall mean electric power and energy used for station stand-by, station start-up, and station auxiliary power requirements to operate the electric equipment at the premises of an electric generating facility or for other end use at the premises (including heating, lighting, air-conditioning, and office equipment needs) related to the operation, maintenance, or repair of the facility. Station Power does not include any electric power and energy used at a service connection:

1) to power a synchronous condenser operating under the provisions of a tariff establishing rates for such condensing that is on file with the Federal Energy Regulatory Commission, or
2) for pumping at a pumped storage facility, or
3) in the association with the restoration of the transmission system located in EED's service territory, or
4) to provide system black start service in the event that restoration of the transmission system is required.
Responsibilities of the GIC

The GIC is responsible for designing, installing, operating, and maintaining its own equipment in accordance with Good Utility Practice(s), IEEE 1547, the National Electrical Code, the National Electrical Safety Code, North America Electric Reliability Council, any applicable independent system operator, EED planning criteria and guidelines, service requirements and all applicable laws and regulations. This includes installing, setting, and maintaining all protective devices necessary to protect the GIC’s facilities. The requirements specified in this document are designed to protect EED facilities and to maintain system reliability, not to protect the GIC’s facilities.

NOTE: IMPORTANT EXCEPTION TO IEEE 1547 SETTINGS BY COMED

ComEd’s reclosing practice is to have a first reclose after the protective device has been open for 2 seconds and a second reclose after 30 seconds. IEEE1547 protective guidelines call for the first level of tripping to occur after 2 seconds. This means that the generator could still be connected when the ComEd line is reclosed. To avoid this harmful condition, the first trip level of tripping must be reduced from 2 seconds to 1 second. PECO’s reclose timing is different and this exception does not apply to PECO.

Regulatory Requirements for Interconnection

Retail Electric Service

Exelon allows a GIC to interconnect to EED's system located within EED’s service territories for the purpose of supplying their own electric energy needs and in some cases to supplying electric power and energy to the PJM wholesale market, and for the purpose of receiving electric power and energy for end-use consumption by the GIC's generating facilities, often called “Station Power”. Consistent with state and federal laws, a GIC will be allowed to receive electric power and energy to serve its Station Power via:

1. local self-supply, which is provided by the GIC without use of EED's transmission or distribution systems;
2. remote self-supply, which is self-provided by the GIC either by a physically “on-site” but electrically remote generator, or by a physically and electrically remote generator; and/or
3. third party supply.

Both remote self-supply and third party supply utilize EED's system for delivery purposes.

In Illinois, third party supply can be provided by either a certified Retail Electric Supplier (RES) or by ComEd. In Pennsylvania, third party supply can be provided by either a certified Electric Generation Supplier (EGS) or by PECO Energy.
For more information regarding retail electric service options, either contact your ComEd Account Manager or PECO Energy Account Manager, as applicable, or visit "Energy Rates" section contained within the ComEd or PECO links on Exelon's web site: www.exeloncorp.com.

**Interconnection Configuration**

EED will determine the bus and line configurations and protection requirements that are necessary to interconnect the generation to the T&D System, as requested by the GIC. In order to perform such an analysis, EED will require technical information on the GIC generator(s) and proposed interconnection location to the system. In the case where the customer wishes to participate in the PJM energy market, PJM will also be involved in the interconnection study.

These interconnection configurations are site dependent. Examples of typical interconnection configurations and general relay requirements for these configurations are discussed in the sections below. Once the appropriate configuration is determined, EED will provide the GIC with the scope, schedule and cost of the interconnection facility.

**Supply from the Low Voltage Network**

A low voltage networks is an extremely reliable form of electric service and extreme caution must be used when connecting generators to this type of service. High reliability is achieved by designing the system to carry full load with any primary feeder/line out of service and by rapidly removing any faulted primary feeder from connection to the low voltage network. Improper coordination of the generator and the network protection can bring down the entire network and may result in catastrophic failure of EED and customer equipment. EED operates two forms of secondary networks. These are Spot networks and grid networks. Spot networks at EED consist of 2 to 4 network transformers each fed by different primary feeders that connect to a common secondary bus. Network protectors open and close for changing load requirements and to isolate faulted primary feeders through the network relays. Typically a spot network feeds one customer, but it is possible to feed several customers from a network vault. All the transformers and the secondary bus are located in one area and feed a local concentrated load. Grid networks differ in that they serve a large geographic area and a large number of customers by running secondary main conductors between network centers, with customer loads tapped off the secondary mains in manholes.

Spot networks exist at various locations in the ComEd service territory, but grid networks exist only in the downtown and near north side of Chicago and in Evanston. PECO operates a small form of network grid service in downtown Philadelphia. Grid networks are 120/208 Volts at ComEd and 2-phase 5-wire 120/240 volts at PECO. Spot networks can be 120/208 or 277/480 volts.

Small amounts of non-islanding inverter based generation will be allowed on spot and grid networks, so long as the generation is not more than 5% of the peak load on the network center or a maximum of 50 kW (See Exelon Energy Delivery Interconnection Guidelines for Generators 2 MVA or less).
Momentary Parallel Generation

Generation that is connected to the EED System for 10 cycles or less is considered Momentary Parallel Generation. This type of parallel generation generally does not require the protection described in this guide. EED will determine if any unusual system conditions exist that would require the relaying described in this book. Note that it is the customer’s responsibility to design and protect these momentary connections to insure safe and reliable operation. Momentary generation transfer schemes are to be supervised by hard-wired timing relays or an equivalent interlocking scheme. The customer will be required to field verify to EED that the transfer takes place in 10 cycles or less. If the installation fails the test or if the paralleling time period is intentionally over 10 cycles, relaying per this guide will be required.

Design B

Requirements for Design B Designation

Medium-sized generators (2000 -10,000 kVA) can supply relatively large amounts of energy to the point of fault; therefore, additional protective functions are required. A generator connected to an EED supply line section with a minimum load less than twice the rating of the generator also stands a very good chance of islanding after the line protective equipment opens with or without the fault remaining on the line. There are also instances where special system constraints may require using this design. If there are multiple generators on a single EED supply line section, a Design C protection scheme may be required instead of a Design “B”.

Highlighted Protective Relaying Functions

A point of fault electrical arc will not be extinguished until the line protective equipment and the generator are tripped, totally de-energizing the line section. Automatic reclosing of the source circuit breaker will not be able to restore service unless the arc is extinguished. For these reasons, phase and ground fault detecting relays, in addition to voltage and frequency relays, are required at the generator point of interconnection. Voltage supervision of automatic reclosing and synchronism check supervision of manual closing is required for the EED circuit breaker or recloser at the line section source to minimize the risks of equipment damage and personal injury should an attempt be made to close the source circuit breaker or recloser with the generator still on line. If the power transformer at the interconnection is delta-connected on the EED supply (Normal for ComEd transformers), then a single phase-to-ground fault will not draw fault current once the line section protective equipment opens; however, the system will be over-voltaged. To prevent this from happening, voltage sensing on the EED supply side of the power transformer is required. The rest of the protective relay requirements for Design “B” are detailed in Appendix 1.

Design C

Requirements for Design C Designation

High-speed protection of transmission lines is essential to maintain system stability and insure the integrity of the transmission system. Likewise, large generators (greater than 10MVA) can deliver very large amounts of energy to a fault. The level of protection increases under these conditions. There are also instances where special system constraints may require using this design. There may also be stability concerns.
Highlighted Protective Relay Functions

All sources connected to a transmission line, 69kV and above, are designed to open within 0.1 second for faults anywhere on the line. Line transfer trip (i.e., high speed communication) is required to fulfill this requirement for GIC generation. Transfer trip is required to trip the generator for any islanding conditions. Transfer trip is also required if the generator is approximately 10 MVA or greater and connected to the 34kV and 12kV system. Design “C” provides the facilities needed for high-speed transfer trip. To insure high-speed operation, a distance relay with no intentional time delay may be required. If the GIC’s generation is greater than 50% of the minimum line section load and they export power on to the EED T&D lines, then Design “C” should be considered. The rest of the protective relay requirements for Design C are detailed in Appendix 2.

Multiple Generating Installations on a Single EED Supply Line

Protection requirements for the addition of generation to an EED supply line with existing generation have to be made on a case by case basis. The possibility exists that under these circumstances an installation that might be considered a Design B may require Design C type protection. The addition of generation to the supply line may require additional protection at the existing installation. As a general rule, the protection at the EED source station will be determined by the total generation on the line.
GIC Engineering Design and Construction

At PECO the GIC is responsible for coordinating the design of its own generator step-up electrical facility with EED that corresponds to EED standards. At ComEd for installations of this size, EED typically owns and supplies the required step down transformer at the interconnection to the customers facilities. Appendix 1&2 provides relay requirements. Appendix 8 provides information on substation design standards, and Appendix 9 provides information on transmission design standards.

EED’s functional relay requirements will be given to the GIC, using the Relay Functional Requirements Specifications (RFRS) form. Sample copies of this form are included in Appendix 1&2.

The RFRS form for a specific project shows the protective functions for which the GIC is to provide relays and related equipment. The GIC must indicate on the RFRS form the specific relay type 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. The completed RFRS forms and related information, including the corresponding one-line diagrams, are to be returned to EED.

Before proceeding with construction, the GIC must furnish six sets of final design documents to EED (& PJM if applicable) for review and approval. GIC design documents (electrical prints, relay settings, etc) will be reviewed by EED (and PJM if applicable) within 60 days. 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 EED System
- Three-line diagrams showing current and potential circuits for protective relays
- Relay tripping and control schematic diagram
- Instruction books for relays on the RFRS forms
- A written summary of various operating sequences for the proposed generation

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 EED before proceeding with construction.
Philosophy of Required Protection

General Need for System Protection in the Presence of Parallel Generation

The components of the EED system are subject to a variety of natural and man-made hazards, among these are lightning, wind, wildlife and vandalism. Damaged or short-circuited equipment should be switched out of service as soon as possible to minimize safety hazards and to avoid additional equipment damage.

Generation operated in parallel with the EED system provides an additional source of energy which must also be disconnected in case of an emergency. Because parallel generation may interfere with the operation of protective devices normally used by the EED system, it is essential that a suitable system of protection be used to minimize hazards and to prevent the reduction of quality of service to other EED customers.

General Effects of Parallel Generation on System Protection Requirements

The addition of generation should not introduce a hazard or adversely affect the quality of service to EED customers.

Protective equipment must be added to standard EED facilities to provide adequate protection of the EED system. Requirements for additional protective equipment due to parallel operation will vary depending on the size of the customer’s generation and load and on the nature of the EED local T&D system. The requirements range from a simple protection system, if the generator is small and if energy is always intended to be delivered from the EED system to the GIC, to complex high speed schemes for larger generators and net exporters of power.

A simple protection scheme may be required for smaller generators. This is true when isolation of the generator from the EED system leaves the generator connected to a large amount of load resulting in rapid voltage collapse and automatic shutdown of the generator.

Special protection is likely to be required for large generators, especially if the generator is large enough to carry more than the GIC’s own load. For such installations, special devices may be required to detect faulted equipment on the EED system, as well as devices to detect isolated operation.

Reclosing of EED Supply Lines

Role of Automatic Reclosing.

Most faults on an overhead transmission or distribution line are transient in nature. That is, if the line is de-energized promptly, it can be reclosed and returned to service. Examples of such transient faults include momentary tree contact due to wind and insulator flashover due to lightning. Automatic reclosing of overhead lines is standard industry practice to improve the reliability of supply. In some cases, the line can be de-energized and reclosed within 20 cycles with minimum disruption of service to the customers.

Effects of Parallel Generation on Automatic Reclosing.

Automatic reclosing, however, presents a potential for damage to generating equipment operated in parallel with the utility. Severe mechanical stress on the GIC’s equipment may occur if the supply line is reclosed while the generator is still connected to the GIC’s system. This applies to both synchronous and induction generators. It is commonly recognized that this applies for synchronous generators which are out of synchronism when the utility supply is
restored. Damage may also occur if induction generators are operating at a speed higher or lower than normal when reclosed to the utility system. Reclosing under these conditions can also cause potential hazard or damage to EED facilities or other GICs.

This situation is not limited to automatic reclosing of the line which directly supplies the GIC. For some system conditions, automatic reclosing of transmission or sub-transmission lines (which are part of radial supply to the GIC) may result in the same type of situation.

As a general philosophy, EED will not eliminate automatic reclosing of overhead supply lines because that would severely reduce the reliability of service to other EED customers. Possible Reclosing Scenarios and GIC Responsibilities.

In general, the GIC is responsible for protecting the generating facility’s equipment so that automatic or manual reclosing, faults, or other disturbances on the EED system do not cause damage to his equipment.

When automatic reclosing may result in equipment damage or a safety hazard on the EED system or EED customer facilities, EED will require that additional protective equipment be installed. This will usually consist of communication and/or control equipment to disconnect the GIC’s generator (or to confirm that it is disconnected) before the EED supply line is reclosed.

When potential damage or hazard involves only the GIC, EED may recommend that the GIC pay for additional equipment on the EED system to minimize the potentially adverse effects of automatic reclosing. The installation of suitable facilities is strongly recommended as the best engineering solution to minimize the problems.

Revenue Metering Guidelines

For 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 EED 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 (see Appendix 6 for additional details), applicable contractual provisions and associated tariffs. Another guideline concerning all generation and auxiliary metering is the ability to connect to an 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 EED 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 GIC address at which its use is intended
• Estimated generation capacity and auxiliary retail loads

All retail metering shall be owned by EED.

Telemetry Requirements

Some generators will require continuous telemetry to EED’s and PJM’s operation facilities. These will typically be large generators, generators involved in wholesale transactions or generators that are dispatchable by PJM. Telemetry may be required for one or more of the following reasons:

• **System Control.** EED and PJM have an obligation to maintain frequency and generation/load balance within its service territory. Changes in the status of large amounts of generation, without real-time telemetry, are detrimental to system control.

• **Transmission System Operation.** The status of large generators significantly impacts operating decisions. Operators need to know the status of these large generators before performing routine or emergency switching.

**Transfer Trip Equipment Installed at the Site.** The status of the transfer trip channel has to be monitored to verify the health of this channel and quickly resolve channel failure problems. Also control to turn on and off the transfer trip equipment remotely is required at the generation site.

• **Public Safety.** Generators can potentially keep a portion of the electrical grid energized while isolated from the EED System. It is critical to detect these situations as soon as they occur so that corrective action can be taken, since the safety of the public and of EED workers is at stake.

Generators that meet the following criteria require implementation of telemetry to EED’s and possibly PJM’s control center. Required telemetry is listed below each criterion. If more than one criterion applies to a generator, the telemetry requirements of each criterion must be met.

1. If the GIC is involved in a Power Purchase Agreement (PPA) or participating in the PJM capacity markets which contains unit specific performance or a unit specific payment structure.
   ◆ Continuous telemetry required.
   ◆ Instantaneous revenue grade MW and MVAR; and cumulative revenue grade MWhr and MVARhr at the generator’s step-up transformer high side (or equivalent net output) for each unit.
   ◆ Instantaneous revenue grade MW and MVAR; and cumulative revenue grade MWhr and MVARhr at all points of interconnection with EED and all points of service from EED.

2. If multiple GIC’s generators over a large area with an aggregate generation greater than 40 MW are being centrally controlled.

Original 10-31-2006
Continuous telemetry required.
Aggregate instantaneous MW of all generators.

Appendix 6 provides EED’s telemetry standards. PJM telemetering requirements can be found in PJM Manuals M-01 and M-14 D. Details of the specific telemetry requirements will be provided at the initial project meeting with EED and PJM. The GIC will be responsible for the installation cost and monthly communication costs of the required telemetry.

Real Estate Guidelines

If the GIC will be constructing a substation to be owned, operated and maintained by EED, on their property to facilitate interconnection, then the real estate requirements in Appendix 7 apply to the Construction Service Agreement for the GIC’s project.

Testing and Acceptance Requirements
Inspection, Testing, and Authorization

EED 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 GICs facilities.

The GIC must furnish to EED the proposed settings for relays specified on the RFRS. If requested, EED will provide system data needed to determine the relay settings. Before parallel operation with the EED System, the installation must be witnessed and inspected by EED. EED, in cooperation with PJM, will set the testing requirements. EED has the right to witness the tests and inspect before energizing the equipment. The GIC must notify EED (and in specific cases PJM) 10 days before energizing the equipment. The GIC is responsible for providing qualified personnel who will complete all required tests. EED 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. EED in collaboration with PJM will provide a list of proposed tests to be witnessed (also see Appendix 3).

A description of proposed typical tests is in Appendix 3 — Pre-Interconnect Inspection Standards. The witness test list for a given site will be the ultimate governing document. EED tester’s time is generally scheduled at least 6 weeks in advance by the Regional Testing Group Work Management department. Testing Group individuals are not scheduled for work until completed and approved prints, and other required documentation, are in hand. GIC representatives shall work with EED work management to schedule tester’s time for witness testing and review of testing documentation. Four (4) sets of approved prints (as built) must be provided to the EED testing department. Project delays caused by untimely submittal of approved prints are the responsibility of the GIC.
• **Warning**: Initial energizing of high voltage circuits will not be allowed until the site design has been approved (and if applicable all requirements of the PJM Tariff have been satisfied). Energizing equipment without required approval may result in disconnection from the EED system.

**Operations Requirements**

EED is responsible for ensuring the stability and reliability of its electric EED T&D system. On the bulk power transmission system, PJM works in conjunction with EED to ensure stability and reliability. In turn, all GICs are responsible for operating their units in a stable manner while those units are connected to the EED System. Generator excitation and prime mover controls are key elements in ensuring electric system stability and reliability. When connected to the transmission system, 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. When connected to the distribution system, unless otherwise specified, GIC’s are not to actively regulate voltage in accordance with IEEE 1547 - 4.1.1.

In general EED/PJM will not provide any guidance on the planning, operation and maintenance of small generators 20 MVA and below on the EED system. EED does provide guidelines on the interconnect relaying as detailed in this guide. It is the GIC’s responsibility to plan operate and maintain their generator in a reliable and safe manner. GIC’s connected to the transmission system or those greater than 10 MW involved in the export of power to the EED system, may be required to follow the following regulations:

ReliabilityFirst planning and operating requirements can apply to new and previously connected GIC’s. Upon notification from ReliabilityFirst, these requirements can be audited including requests for data or oscillography. These standards are publicly available from the NERC, PJM, and ReliabilityFirst home pages (http://www.nerc.com/), (http://www.pjm.com/) and(http://www.reliabilityfirst.com/Reliability/ReliabilityHome.aspx). In the event these regulations apply, PJM will detail the requirements that the GIC must follow.

**Monitoring of Generators**

If the GIC is greater than 10 MVA and/or requires transfer trip, then EED requires that the GIC supply specific operational values (i.e. position of breakers, watts, vars, volts, unit status, etc.) in real-time via telemetry reporting. This electronic reporting is to be configured to come back directly into EED’s Energy Management System. This reporting specification is in addition to any requirements that the GIC may have for reporting similar operational values to PJM as defined by the Interconnection Service Agreement.

Operation of an EED Transmission Line in Parallel with the GIC

Original 10-31-2006
On occasion, EED 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 GIC, EED (and possibly PJM) will coordinate for these planned outages.

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

- During planned outages, or if the GIC is not permitted to operate the generator in parallel with a line while EED performs “Liveline Maintenance”, EED may lockout the generator (or other breaker designated by the GIC) to prevent its closing into EED’s line(s). A GIC must notify EED before bringing a generator on line. EED may require the GIC to delay synchronizing when EED is experiencing line trouble or system disturbances.
- A GIC must not energize supply lines interconnecting with EED’s facilities or continue to maintain supply to EED lines after EED has deenergized its lines. EED may discontinue parallel operation during emergencies and under abnormal operating conditions. EED’s Operation Center dispatcher will call the GIC asking to isolate the generator from the EED system. If no one can be reached, EED may take other measures on its T&D lines to isolate the generator.
- A GIC is responsible to evaluate the potential effect of EED’s reclosing practices on the generator and to provide suitable protection.

**GIC Operators Training**

Individuals with plant oversight responsibilities and who are performing the role of an operator should be trained on the specifics of how their equipment connects to the transmission system. In addition, when performing equipment manipulations within their facilities, these individuals should be aware of the possible effects of operating that equipment may have on the T&D system in general.
Appendix 1: Design B Requirements for Generating Capacity Greater than 2500kVA to 10MVA

PRELIMINARY RELAY REQUIREMENTS
GIC OWNED GENERATION PARALLELED WITH EED
FOR REPLY TO SERVICE ESTIMATE REQUEST

DESIGN B

THIS DESIGN IS FOR GENERATION FACILITIES WITH THE FOLLOWING CHARACTERISTICS:

A. TOTAL GENERATION IS GREATER THAN OR EQUAL TO 50% OF THE MINIMUM LINE SECTION LOAD.

B. TOTAL GENERATION IS GREATER THAN OR EQUAL TO 2000kVA AND LESS THAN 10MVA.

C. SPECIAL SYSTEM CONSTRAINTS WARRANT USING THIS DESIGN.

THESE RELAY REQUIREMENTS ARE FOR ESTIMATING PURPOSES ONLY

SCADA RTU

OTHER LOAD

MORE TYPICAL AT PECO

MORE TYPICAL AT CUMEED

THESE NUMBERS REFER TO THE DEVICE TYPE NOTES ON THE ATTACHED PAGES.
Design B - Notes for Relay Functional Requirements Specification (RFRS) Form and Preliminary Relay Requirements Diagram

This design is for Generation Facilities with the following characteristics:

Generation is not to be intentionally exported on to the EED T&D system.

---and---

a. Total generation is greater than or equal to 50% of the minimum line section load.

---or---

b. Total generation is greater than 2000 kVA and less than 10 MVA.

---or---

c. Special system constraints warrant using this design.

Relay requirement/recommendation and installer are dependent upon EED/GIC property line location. Required relays are to be approved by EED.

W: Protection required by EED due to GIC's parallel generation; to be installed by EED at GIC's expense.

X: Protection required by EED due to GIC's parallel generation; to be installed by GIC at GIC's expense.

Y: Protection recommended by EED due to GIC's parallel generation; to be installed by GIC at GIC's expense.

Z: Protection recommended by EED due to GIC's parallel generation; to be installed by EED at GIC's expense.

EX: Existing relay or equipment.

N/A: Not applicable in this case.

IN: Equipment to be installed.

Protective Device Numbering

The following requirements and examples, the nomenclature and numbering of protective devices will follow the standards set forth in ANSI C37.2. This standard numbering should also be used by the customer on information provided to EED showing customer equipment. All relays are to be utility grade relay and to be approved for use on the EED system.

A few of the more commonly used devices are shown in the following list:

2 Timer

Original 10-31-2006
Notes for Design B (Continued)

4  Master Contactor
21  Distance Relay
25  Synchronizing or Synchronism Check
27  Under-voltage
32  Power Direction
40  Loss of Field Detection
46  Current Balance
47  Voltage Phase Sequence
50FD  Phase Instantaneous Over-current Fault Detector
51  Time Over-current
51G  Ground Time Over-current
51N  Neutral Time Over-current
51V  Voltage Restained/Controlled Time Overcurrent
59  Overvoltage
59G  Overvoltage Type Ground Detector
67V  Voltage Restained/Controlled Directional Time Overcurrent
79  Reclosing Relay
81O  Over-frequency
81U  Under-frequency
87  Current Differential

ADDITIONAL NOTES PERTAINING TO EACH DEVICE TYPE

1. _____
   **Device Type:** Voltage Transformer
   **Number Required:** 3 connected grounded-wye/grounded-wye
   **Purpose:** Provide voltage for manual and automatic closing of source station breaker.

2. _____
   **Device Type:** Undervoltage Relay  **Device #:** 27
   **Number Required:** 3 (may be part of auto-reclosing relay-device type 79)
   **Purpose:** Provide voltage supervision for closing of source station breaker. Breaker may be closed if all 3 phases are dead.
3. ____ Device Type: Synchrocheck Relay  Device #: 25  
Number Required: As required (depends on type) 
Purpose: Provide voltage and phase angle supervision for manual and supervisory closing of source station breaker. Breaker will be manually closed for any of the following indicated conditions, as requested by ______________:  
___ Live Bus - Live Line Synchronized  
___ Live bus - Dead Line  
___ Dead Bus - Live Line  
___ Dead Bus - Dead Line  
___ Not Required

4. ____ Device Type: Voltage Transformer  
Number Required: Depends on type of synchrocheck relay  
Purpose: Provide bus voltage for synchrocheck relay

5. ____ Device Type: Power Transformer  
Number Required: As needed  
Winding configuration to be specified by EED Engr: __________________.

6. ____ Device Type: Breaker Failure Backup Tripping (i.e. LBB)  
Number Required: 1 (may consist of several relays)  
Purpose: Provide for tripping of GIC generator breaker (or other designated back-up breaker) in the event that the Primary interface breaker fails to trip. This relay to be initiated by any customer line fault relay.

7. ____ Device Type: Voltage Transformer  
Number Required: 3 connected grounded-wye line side and either broken-delta or grounded-wye on secondary side. Required when a delta primary or secondary interconnection transformer is present.  
Purpose: Provide voltage to 59G or 27 relays for faults involving ground on the EED system. Preferred connection is broken-delta; but if feeder loading is unbalanced to the point that three times zero-sequence voltage is normally significant, then the secondary side should be connected grounded-wye. If this VT is to provide voltage also for impedance relays or directional relays and is to be used for a 59G relay, then the VT may be a three winding type with the third winding connected grounded-wye or the broken-delta connection may be provided by using an aux. VT (grounded-wye/broken-delta) if the main VT is grounded-wye/grounded-wye. The 27 relay could be part of the 27/59 relaying (specified in note 21) if the 27/59 VT’s are located on the primary side of the interconnection transformer. This relaying is to provide a relay failure output to trip a selected customer breaker between the EED system and the customers generator or a back-up relay is to be installed.
Notes for Design B (Continued)

8. Device Type: Over or Undervoltage Relays Device #: 59G or 27
   Number Required: 1 if 59G or 3 if 27 relay
   Purpose: Provide tripping of customer breaker(s) in the event of a fault on the ComEd system involving ground. If the VT's are connected broken-delta, then the relay used is the 59G overvoltage type. If the VT's are connected grounded-wye on the secondary, then the relays used are the 27 undervoltage relays.

   Number Required: 1 Impedance relay plus 1 timer
   Purpose: Provide for tripping of customer breaker in the event of a phase fault on the ComEd system. This relay is used in a Zone 2 mode. The timer should be capable of providing a trip time in the .5 second to 2 seconds range.

10. Device Type: Voltage Transformer
    Number Required: 3 connected grounded-wye/grounded-wye
    Purpose: Provide voltage for impedance relays and power directional relays.

11. Device Type: Ground Overcurrent Relay Device #: 51G
    Number Required: 1
    Purpose: Provide for tripping of customer breaker in the event of a fault involving ground on the customer system. This relay may be in the transformer neutral.

12. Device Type: Overcurrent Relay Device #: 51
    Number Required: 3 or 1 3-phase
    Purpose: Provide for tripping of customer breaker in the event of a phase fault on the customer system.

13. Device Type: Directional Power Relay Device #: 32
    Number Required: 1 or 3 depending on type
    Purpose: Provide for tripping of customer breaker if the transformer size is smaller than generator, to limit power out if necessary to prevent damage to other customers, or to limit power out because of EED system constraints. This relay is not used for fault detection.

14. Device Type: Synchronizing Relay Device #: 25
    Number Required: As required by the number of generator and transformer breakers needing synchrochecking. Additional synchronizing relays or interlocks may be required at other circuit breakers that could initiate paralleling of the generator to the EED system. Not needed for most induction-type machines.
    Purpose: Provide for proper closing of breakers when the customer generator(s) are to be paralleled to the ComEd system.

15. Device Type: Voltage Transformer
Notes for Design B (Continued)

Number Required: As required for synchronizing
Purpose: Provide voltage for synchronizing relays. May be one connected phase-to-phase or may be a part of a 3-phase voltage transformer package.

16. **Device Type:** Voltage Transformer
   **Number Required:** 3 connected grounded-wye/grounded-wye
   **Purpose:** Provide voltage for under/over voltage and under/over frequency relays. These voltage transformers to be connected on the primary or secondary side of power Transformer. One location only as specified by the EED Engineer.

17. **Device Type:** Under/over Frequency Relay  **Device #:** 81U/O
    **Number Required:** 1
    **Purpose:** Provide tripping of customer breaker in the event the frequency fails to be maintained. This relay would be expected to operate if the customer should become isolated on the ComEd line and not be able to maintain the load. The relay is to have a minimum of one over-frequency and two under-frequency elements with a definite-time type characteristic capable of providing a trip time in the 0.1 second to 2 second range. The setting is to conform to IEEE 1547 section 4.2.4 (Note ComEd reclosing exception in this document), unless dictated by other EED system constraints. Frequency relays are to be connected to VT’s on the primary or secondary side of power Transformer. One location only as specified by the EED Engineer.

18. **Device Type:** Under/over voltage relay  **Device #:** 27/59
    **Number Required:** Depends on type
    **Purpose:** Provide tripping of customer breaker in the event the feeder or line voltage not be maintained within acceptable limits. This relay should be a definite-time characteristic or an instantaneous type with a timer. The relay is to have a minimum of two over-voltage and two under-voltage elements with capable of providing a trip time in the 0.1 second to 2 second range. The setting is to conform to IEEE 1547 section 4.2.3 (Note ComEd reclosing exception in this document), unless dictated by other EED system constraints. Voltage relays are to be connected to VT’s on the primary or secondary side of power Transformer. One location only as specified by the EED Engineer.

19. **Device Type:** Interrupting Device
    **Number Required:** As needed
    **Purpose:** May be a fuse or circuit breaker. Circuit breaker must not be dependent upon A.C. power for tripping.

20. **Device Type:** Relay Failure Protection
    **Number Required:** As needed
    **Purpose:** To provide back-up relay protection should the primary relays fail. The relay fail contact of microprocessor relays set up to trip the generator breaker of other
Notes for Design B (Continued)

designated breaker can fulfill this requirement. If a PLC is installed at the site that performs critical generator functions, a back-up PLC is to be installed or a health check output is to be wired in to trip the generator breaker for the failure of the PLC.

21. _____ Device Type: Automatic Transfer Inhibit Scheme
Number Required: 1
Purpose: Where the GIC is fed from two or more EED primary lines through a primary selective transfer scheme (ATO), the scheme must be inhibited from operating until the generator is isolated from the EED line.

22. _____ Device Type: Circuit Breaker Trip Coil Monitor
Number required: As needed per the number of generators
Purpose: Where possible the interconnect circuit breaker trip coil is to be monitored to detect a failed trip coil and alarm the condition

23. _____ Device Type: Relay Setting Note (Line Impedance)
Purpose: to assist the GIC in setting protective relays at their site
Impedance of interconnect transformer: _______________________________________
Line Impedance between the GIC and the EED substation: _______________________
Line impedance for which the DR must see and clear faults: ____________________

24. _____ Device Type: Remote Terminal Unit (RTU)
Number Required: 1 for EED & (1 for PJM as Required)
Purpose: To monitor and control the transfer trip equipment, to monitor GIC circuit breaker status’s, to monitor generator analogs and to monitor interconnection point analogs. The GIC is to supply an acceptable lockable space for the installation of the RTU equipment. GIC is to provide a dedicated circuit from his DC battery to power the RTU.
### RELAY FUNCTIONAL REQUIREMENTS

**SPECIFICATIONS...DESIGN B**

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**LOCATION:** ___________________________  **DATE:** ___________________________

**CONNECTED TO:** ___________________________  **FIRST ISSUED:** ___________________________

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**THE INFORMATION BELOW IS TO BE FURNISHED BY THE CUSTOMER AND RETURNED TO EED**

**NOTES REFER TO “PRELIMINARY” RELAY REQUIREMENTS FOR DESIGN B**

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* RELAYS ARE TO BE APPROVED BY EED BEFORE GIC PURCHASE

**RETURNED BY:** ___________________________

**ADDITIONAL NOTES:** ______________________________________

**RETURN TO:** ___________________________

**ADDRESS:** Relay and Protection Services.
2 Lincoln Centre
Oakbrook Terrace, Illinois 60181-4260

**RETURNED BY:** ___________________________

**CUSTOMER/CONSULTANT** (Signature/Date)

---

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Appendix 2: Design C Requirements for Generating Capacity Over 10MVA

PRELIMINARY RELAY REQUIREMENTS
GIC OWNED GENERATION PARALLELED WITH EXELON.
FOR REPLY TO SERVICE ESTIMATE REQUEST

DESIGN C

THIS DESIGN IS FOR GENERATION FACILITIES WITH THE FOLLOWING CHARACTERISTICS:

A. GENERATION LESS THAN 10 MVA CONNECTED TO 69KV OR 138KV.

B. GENERATION GREATER THAN OR EQUAL TO 10 MVA CONNECTED TO THE DISTRIBUTION SYSTEM.

C. GENERATORS THAT EXPORT POWER TO EED AND HAVE A NAMEPLATE KVA GREATER THAN 50% OF THE MINIMUM LINE SECTION LOAD.

D. SPECIAL SYSTEM CONSTRAINTS WARRANT USING THIS DESIGN.
This design is for Generation Facilities with the following characteristics:

   a. Total generation is greater than or equal to 10MVA but less than or equal to 20MVA.

   b. The EED supply line voltage is 69kV or above.

   c. Special system constraints warrant using this design.

   d. Generation if greater than 50% of the minimum line section load and the customer is intentionally exporting to the EED T&D system

Relay requirement/recommendation and installer are dependent upon EED/GIC property line location. Required relays are to be approved by EED.

W: Protection required by EED due to GIC's parallel generation; to be installed by EED at GIC's expense.

X: Protection required by EED due to GIC's parallel generation; to be installed by GIC at GIC's expense.

Y: Protection recommended by EED due to GIC's parallel generation; to be installed by GIC at GIC's expense.

Z: Protection recommended by EED due to GIC's parallel generation; to be installed by EED at GIC's expense.

EX: Existing relay or equipment.

N/A: Not applicable in this case.

IN: Equipment to be installed.

Protective Device Numbering

The following requirements and examples, the nomenclature and numbering of protective devices will follow the standards set forth in ANSI C37.2. This standard numbering should also be used by the customer on information provided to EED showing customer equipment. All relays are to be utility grade relay and to be approved for use on the EED system.

A few of the more commonly used devices are shown in the following list:

2 Timer
Notes for Design C (Continued)

4  Master Contactor
21  Distance Relay
25  Synchronizing or Synchronism Check
27  Under-voltage
32  Power Direction
40  Loss of Field Detection
46  Current Balance
47  Voltage Phase Sequence
50FD Phase Instantaneous Over-current Fault Detector
51  Time Over-current
51G  Ground Time Over-current
51N  Neutral Time Over-current
51V  Voltage Restrained/Controlled Time Overcurrent
59  Overvoltage
59G  Overvoltage Type Ground Detector
67V  Voltage Restrained/Controlled Directional Time Overcurrent
79  Reclosing Relay
81O  Over-frequency
81U  Under-frequency
87  Current Differential

ADDITIONAL NOTES PERTAINING TO EACH DEVICE TYPE

1.____ Device Type: Voltage Transformer  
   Number Required: 3 connected grounded-wye / grounded-wye  
   Purpose: Provide voltage for manual and automatic closing of source station breaker.

2.____ Device Type: Undervoltage Relay  Device #: 27  
   Number Required: 3 (may be part of auto-reclosing relay device #79)  
   Purpose: Provide voltage supervision for closing of source station breaker. Breaker may be closed if all 3 phases are dead.

3.____ Device Type: Synchrocheck Relay  Device #: 25  
   Number Required: As required (depends on type)  
   Purpose: Provide voltage and phase angle supervision for manual and supervisory closing of source station breaker. Breaker will be manually closed for any of the following indicated conditions as requested by ________:

   ______ Live bus - Live line synchronized

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**Notes for Design C** (Continued)

- Live bus - Dead line
- Dead bus - Live line
- Dead bus - Dead line
- Not required

4. **Device Type**: Voltage Transformer  
   **Number Required**: Depends on type of synchrocheck relay  
   **Purpose**: Provide bus voltage for synchrocheck relay

5. **Device Type**: Power Transformer  
   **Number Required**: As needed  
   Winding configuration to be specified by EED Engr: _________________

6. **Device Type**: Transferred Trip Transmitter  
   **Number Required**: 1  
   **Purpose**: Provide for tripping of customer breaker in the event that the source station breaker should open. May be keyed by line relaying, bus relaying or 52b contact.

7. **Device Type**: Transferred Trip Receiver  
   **Number Required**: 1  
   **Purpose**: Receive transferred trip signal from source station so as to trip the customer breaker. The GIC is to supply an acceptable lockable space for the installation of the transfer trip equipment. GIC is to provide a dedicated circuit from his DC battery to power the Transfer Trip equipment.

7A. **Device Type**: Phone lines for Transfer Trip Equipment  
   **Number Required**: 2  
   **Purpose**: Communications for Transfer Trip Equipment. Customer to supply 2 – “C2” Class “A” 4 wire analog telephone circuits per ComEd line

8. **Device Type**: Breaker Failure backup tripping (i.e. LBB)  
   **Number Required**: 1 (may consist of several breakers)  
   **Purpose**: Provide for tripping of the customer generator breaker in the event that the interface breaker fails to trip. This relay to be initiated by any customer line fault relay.
9. **Device Type**: Voltage Transformer  
**Number Required**: 3 connected grounded wye line side and either broken-delta or grounded-wye on secondary side. Required when a delta primary or secondary interconnection transformer is present.  
**Purpose**: Provide voltage to 59G or 27 relay for faults involving ground on the ComEd system. Preferred connection is broken-delta but if feeder loading is unbalanced to the point that the 3 times zero sequence voltage is normally significant, then the secondary side should be connected grounded-wye. If this VT is to provide voltage also for impedance relays or directional relays and is to be used for a 59G relay, then the VT may be 3 winding type with the third winding connected grounded-wye or the broken-delta connection may be provided by using an aux. VT (grounded-wye/broken-delta) in conjunction with VT provided by note 22.

10. **Device Type**: Over or Undervoltage Relays  
**Device #:**: 59G or 27  
**Number Required**: 1 if 59G relay or 3 if 27 relay  
**Purpose**: Provide for tripping of customer breaker(s) via time delay in the event of a fault of ComEd system involving ground. If the VT’s are connected broken-delta then the relays used is the 59G overvoltage type. If the VT’s are connected grounded-wye on the secondary, then the relays used are the 27 undervoltage relays.

11. **Device Type**: Fault Detector  
**Device #:**: 50FD  
**Number Required**: 1 or 3 depending on type. CT ratio is _________  
**Purpose**: Fault Detector for 21-1 and 21-2 relays (notes 12 and 13). If the CT’s are on the low voltage side of the transformer per notes 12 and 13, this relay can also be connected to CT’s on the low voltage side.

12. **Device Type**: Impedance Relay  
**Device #:**: 21-1  
**Number Required**: 1 *(This relay may not be suitable for all locations.)*  
**Purpose**: Provide for tripping of customer breaker in the event of a phase fault on the ComEd system. This relay is the Zone 1 impedance relay. This relay may be part of a stepped zone phase and ground distance relay package. If CT's are located on the low voltage side of the transformer and the VT is on the high voltage side, then the CT’s and VT’s must be configured for the transformer connection to be used (For example: if a delta-wye transformer is used this relay must receive delta current. See note 22 for required VT location.

13. **Device Type**: Impedance Relay plus Timer  
**Device #:**: 21-2/2  
**Number Required**: 1 Impedance Relay plus 1 Timer  
**Purpose**: Provide for tripping of customer breaker in the event of a phase fault on the ComEd system. This relay is the Zone 2 impedance relay. This relay may be part of a stepped zone phase and ground distance relay package. If CT's are located on the low voltage side of the transformer and the VT is on the high voltage side, then the CT’s and VT’s must be configured for the transformer connection to be used (For example: if
Notes for Design C (Continued)

a delta-wye transformer is used this relay must receive delta current. See note 22 for required VT location. This relay may be on low voltage side (using CT's and VT's located on the low voltage side) if no 21-1 relay is used. The time should be capable of providing a trip time in the .5 second to 2 seconds range.

14. ___  
Device Type: Ground Overcurrent Relay  Device #: 51G  
Number Required: 1  
Purpose: Provide for tripping of customer breaker in the event of a phase fault involving ground on the customer system. If the CT’s are on the low voltage side of the transformer per notes 12 and 13, this relay can also be connected to CT’s on the low voltage side. This relay may be in the customer neutral.

15. ___  
Device Type: Overcurrent Relay  Device #: 51  
Number Required: 1  
Purpose: Provide for tripping of the customer breaker in the event of a phase fault on the customer system. If the CT’s are on the low voltage side of the transformer per notes 12 and 13, this relay can also be connected to CT’s on the low voltage side.

16. ___  
Device Type: Directional Power Relay  Device #: 32  
Number Required: 1 or 3 depending on type.  
Purpose: Provide for tripping of the customer breaker if transformer size is smaller than generator, to limit power out if necessary to prevent damage to other customers, or to limit power out because of EED system constraints. This relay is not used for fault detection. This relay may be located in a CT located on the transformer secondary.

17. ___  
Device Type: Synchronizing Relay  Device #: 25  
Number Required: as required by the number of generator and transformer breakers needing synchrochecking. Additional synchronizing relays or interlocks may be required at other circuit breakers that could initiate paralleling of the generator to the EED system. Not needed for most induction type generators.  
Purpose: Provide for proper closing of breakers when customer generator(s) are to be paralleled to the ComEd system.

18. ___  
Device Type: Voltage Transformer  
Number Required: as required for synchronizing  
Purpose: Provide voltage for synchronizing relays. May be one connected phase to phase or may be part of a 3 phase voltage transformer package.

19. ___  
Device Type: Voltage Transformer  
Number Required: 3 connected grounded-wye/grounded-wye  
Purpose: Provide voltage for under/over voltage and under/over frequency relays. These voltage transformers are required if the 81 and 27/59 relaying is specified by the EED Engr. on the secondary side of the interconnect transformer.
20. Device Type: Under/over Frequency Relay  
Device #: 81U/O  
Number Required: 1  
Purpose: Provide tripping of customer breaker in the event the frequency fails to be maintained. This relay would be expected to operate if the customer should become isolated on the ComEd line and not be able to maintain the load. The relay is to have a minimum of one over-frequency and two under-frequency elements with a definite-time characteristic capable of providing a trip time in the 0.1 second to 2 second range. A solid-state definite time type relay is recommended. The setting is to conform to IEEE 1547 section 4.2.4 (Note ComEd reclosing exception in this document), unless dictated by other EED system constraints. Frequency relays are to be connected to VT’s on the primary or secondary side of power Transformer. One location only as specified by the EED Engineer.

21. Device Type: Under/over voltage relay  
Device #: 27/59  
Number Required: depends on type  
Purpose: Provide tripping of customer breaker should the feeder or line voltage not be maintained within acceptable limits. This relay is to have a minimum of two over-voltage and two under-voltage elements with a definite-time characteristic or an instantaneous type with a timer. The relay should be capable of providing a trip time in the 0.1 second to 2 second range. The setting is to conform to IEEE 1547 section 4.2.3 (Note ComEd reclosing exception in this document), unless dictated by other EED system constraints. Voltage relays are to be connected to VT’s on the primary or secondary side of power Transformer. One location only as specified by the EED Engineer.

22. Device Type: Voltage Transformer  
Number Required: 3 connected grounded-wye/grounded-wye  
Purpose: Provide voltage for impedance relays and power directional relays. May be part of same transformer package as described in note 19.

23. Device Type: Interrupting Device  
Number Required: As needed  
Purpose: May be a fuse or circuit breaker. Circuit breaker must not be dependent upon A.C. power for tripping.

24. Device Type: Relay Failure Protection  
Number Required: As needed  
Purpose: To provide back-up relay protection should the primary relays fail. Back-up relaying is to be provided for the following relay functions: ___________________. The relay fail contact of microprocessor relays set up to trip the generator breaker or other designated breaker can fulfill this
requirement. If a PLC is installed at the site that performs critical generator functions, a back-up PLC is to be installed or a health check output is to be wired in to trip the generator breaker for the failure of the PLC.

25. ____ Device Type: Automatic Transfer Inhibit Scheme  
Number Required: 1  
Purpose: Where the GIC is fed from two or more EED primary lines through a primary selective transfer scheme (ATO), the scheme must be inhibited from operating until the generator is isolated from the EED line.

26. ____ Device Type: Circuit Breaker Trip Coil Monitor  
Number required: As needed per the number of generators  
Purpose: Where possible the interconnect circuit breaker trip coil is to be monitored to detect a failed trip coil and alarm the condition

27. ____ Device Type: Relay Setting Note (Line Impedance)  
Purpose: to assist the GIC in setting protective relays at their site  
Impedance of interconnect transformer: ________________________________  
Line Impedance between the GIC and the EED substation: __________________  
Line impedance for which the DR must see and clear faults: ____________________

28. ____ Device Type: Remote Terminal Unit (RTU)  
Number Required: 1 for EED & (1 for PJM as Required)  
Purpose: To monitor and control the transfer trip equipment, to monitor GIC circuit breaker status’s, to monitor generator analogs and to monitor interconnection point analogs. The GIC is to supply an acceptable lockable space for the installation of the RTU equipment. GIC is to provide a dedicated circuit from his DC battery to power the RTU.
### RELAY FUNCTIONAL REQUIREMENTS SPECIFICATIONS...DESIGN C

**GIC:**

**P.D.:**

**SER NO.:**

**LOCATION:**

**DATE:**

**CONNECTED TO:**

**FIRST ISSUED:**

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**THE INFORMATION BELOW IS TO BE FURNISHED BY THE CUSTOMER AND RETURNED TO EED**

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* RELAYS ARE TO BE APPROVED BY COMED BEFORE CUSTOMER PURCHASE

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**ADDITIONAL NOTES:**

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**RETURN TO:**

**ADDRESS:**

EED Relay and Protection Services
2 Lincoln Centre
Oakbrook Terrace, Illinois 60181 -4260

**RETURNED BY:**

CUSTOMER/CONSULTANT (Signature/Date)

**Original 10-31-2006**
APPENDIX 3- PRE-INTERCONNECT INSPECTION STANDARDS

Witness Testing:

Witness testing requires an EED testing representative to be on site during testing to verify that equipment operates properly. A “Witness Test List” will be provided with a specific list of test required. Overall functional test such as through fault test and functional trip testing will be witness tested.

The Testing Work Management cycle requires scheduling 6 weeks in advance of the actual testing date. The GIC should contact Testing Work Management 10 days prior to any testing to confirm the test date. The EED Testing Department shall be given a minimum of one week to review any testing documentation upon receipt from the GIC’s testing representative. Testing documentation for a particular piece of equipment shall be received as a package.

Testing at the generator site follows review and approval of the GIC’s relay settings and protective relaying schematics. Testing will not commence until the Relay and Protection Services Department has reviewed and approved all required schematics, operational sequences, and settings and these items have been delivered to the testing department. The main items that required witness testing by EED are as follows (the Witness Test List” for a given site will contain specifics):

- Protective sensing circuit (CTs and PTs) and protective relay acceptance test
- Relay calibration test per approved settings
- Functional checks of relay sensing circuits per approved schematics
- Functional checks of relay tripping circuits including breaker tripping per approved schematics
- Functional test of any DC interlocking schemes (Hardwired or PLC) present at the site. Verification of all operational sequences for generator operation.
- Functional checks of relay alarm circuits per approved schematics
- Overall primary current through fault test of line, transformer, and bus differential circuits (if present) and a final trip check of these circuits
- Overall coordination test of permissive overreach line protection schemes and a final trip check of these circuits
- Energization of GIC lines and transformers to follow directly after completion and acceptance of overall tests
- In-service current and voltage circuit test to occur upon initial loading of equipment
- Initial synchronization tests

Initial energization of high voltage circuits will not be allowed until satisfactory completion of all testing items including required through fault test have been witnessed and approve. Energizing equipment without these tests will result in disconnection from the EED system.
Acceptance Tests

The two types of acceptance tests are:

* Initial current and potential transformer acceptance tests

* Relay acceptance testing

Initial Current And Potential Transformer Acceptance Tests

These tests verify that the current transformers (CTs) and potential transformers (PTs) have the correct ratio, polarity, and burden and can be expected to function as per manufacturers specifications. Before these tests, EED must have the latest revision of the vendor prints for the equipment in order to verify nameplate data and get information needed for testing.

Current transformer (CT) tests. These tests include the following:

* Ratio test with enough current through the CT to be able to verify that the ratio of the CT agrees with the ratio on the customer’s prints
* Polarity test using a battery or some other suitable method in order to verify the CT polarity as installed agrees with the customer prints
* Saturation curves test to confirm the manufacturers data for the point at which the CTs will saturate
* Insulation resistance testing of secondary wiring to verify that no grounds in the CT secondary exist other than the one designated in the circuit
* Lamping (continuity) test to verify continuity and prove all connections agree with customer prints for all devices in each secondary current circuit
* Current tests to verify the phasing of the currents before energizing by the lamping method (Comment: Different type of Bullet?)

Potential transformer (PT) tests. These tests include the following:

* Polarity test to verify polarity of each PT as installed agrees with customer print
* Ratio test to verify the specified ratio of the PT with the customer print
* Hi-potential test to verify that the PT will not “break-down” when full potential plus 10% is applied
* Lamping (continuity) test to verify the continuity of the potential to all of the relays and to verify only one ground in the circuit
APPENDIX 3 - PRE-INTERCONNECT INSPECTION STANDARDS

(Cont’d)

Relay Acceptance Testing

The relay manufacturers recommended acceptance test as outlined in the relay instruction
manual must be completed.

Settings

After EED approves the specified relay settings, EED personnel are allowed to witness the
testing and setting of the relays. EED and the customer’s testing personnel must have copies of
the approved settings before testing begins.

Control Tests

EED personnel will witness control checks that include functional verification that all protective
and control relay outputs operate equipment in agreement with customer schematic prints. The
testing of any special operational sequences or interlocks associated with generator operation
(Through hard wiring or a PLC).

Battery and Charger

* Set charger float and equalize voltages
* Set over/under voltage, open battery detector, and ground detector alarms
* Perform receipt inspection of battery per manufacturer instructions
* Test insulation resistance of battery cable and distribution panels at 500 volts DC.
  Minimum value 1 megohm.
* Measure intercell resistance after connectors have been torqued
* Perform initial charge per manufacturer recommendation
* Measure and record cell voltage and specific gravity one week after completion of
  initial charge
* Measure and record cell terminal voltages monthly

SCADA (If present)

* Supply and verify field cable to the remote control and indication equipment cabinet.
Operation of all points will be verified by functional test. Switchyard installer will
operate all required input devices and apply current/voltage to the inputs of transducers to
produce outputs to prove SCADA at EED request.
* It is suggested that all field cables be terminated in the SCADA cabinet(s) by the switchyard installer using plastic hardware (screws and washers) to isolate the SCADA equipment until ready for test.

**Lifted Leads and Jumpers**

* All lifted leads (cable conductors, wires) and temporary jumpers not shown on the design documents are numbered and tagged in the field
* All temporary control jumpers are constructed using #10 wire with red insulation. A log will be kept for all lifted leads and jumpers. The log will include the following data:
  * Lifted lead or jumper number
  * Panel number or physical location
  * Schematic and wiring diagram affected
  * Function of the jumper
  * Reason for lifting the lead
  * Name of the person performing the modification and company affiliation

**In Service Tests**

EED personnel will witness all initial in-service tests including:
* Voltage tests to verify the phasing of the EED service and the customer equipment
* Primary voltage and phasing tests to verify the PT phases after the voltage phasing is known
* Current tests to verify the phasing of the currents by using an ammeter and phase angle meter
* Distance (impedance) relay directionality test to verify that the distance relay is “looking” in the correct tripping direction. This must be a mutually agreed on test.
* Final synchronizing tests to verify the synchronizing of the customer generator to the EED system. A phase angle meter must be used.
* Testing of any generation paralleled momentarily to verify the transfer takes place in 10 cycles or less. For momentary parallel generation, this will be the only test to be witnessed by EED.
Inspection Standards for generation Interconnected at 69kV and Higher

Ground Grid

Verify that all structures and fences are connected to their respective ground grids
Measure overall switchyard ground grid resistance using fall of potential or equivalent method
Verify that microwave ground grid, if separate from station ground, is connected to station ground per design. Maximum allowable switchyard ground grid resistance is 0.5 ohm.

Equipment

Perform power factor (dissipation factor) test on:
  * All high voltage circuit breakers
  * Potential transformers
  * Potential devices
  * Free standing current transformers
  * Power transformers
  * Lightning arresters
  * All other high voltage equipment except stand off insulators

Current Transformers

Tests apply to all current transformers supplying switchyard relays. These tests are as follows:
  * Test insulation resistance of all individual current transformer secondary windings. Required CT insulation resistance at 500 volts DC is 1 megohm minimum.
  * Ratio test by passing the current through the CT primary and measuring the secondary current. Acceptable as tested ratio is the nameplate ratio plus or minus CT accuracy classification.
  * Test all multi-ratio transformers for ratio of all secondary taps by applying approximately 100 volts AC across the entire winding and measuring voltage on each tap lead. Voltage ratios measured will equal CT ratios plus or minus the accuracy class of the CT.
  * Test each CT for polarity. Perform a secondary excitation (saturation) test on all primary (non-auxiliary) CT’s on the in-service tap. Test results should match manufacturer’s specification plus or minus 10%.
  * Verify ratio and polarity as found match the ratio and polarity specified on design documents and equipment nameplates
**Potential Devices**

* Test insulation resistance of the 5 kV primary winding to case at 1,000 volts DC.
* Test insulation resistance of secondary winding to secondary winding at 500 volts DC. Test insulation resistance of secondary to ground at 500 volts DC. Primary winding insulation resistance minimum is 5 megohms; secondary minimum is 1 megohm.
* Backfeed secondary winding(s) at rated voltage and measure exciting current.
* Verify closing the capacitor grounding switch shorts, and grounds the voltage transformer primary winding
* Verify protective gap setting
* Verify ratio and polarity
* Calibrate output for correct phase angle, power factor, and magnitude if the device has provisions for adjustment

**High Voltage Circuit Breakers**

* Perform all manufacturers recommended tests. Verify mechanical tolerances as installed meet manufacturer specification.
* Verify synchronization of individual interrupting chambers within each pole and between poles
* Measure the time to open after trip initiation, time to close after close initiation, time to close after close initiation and time to trip when closing into a made-up trip (trip free operation)
* Measure main contact resistance. Verify set points of all timers, temperature, and pressure sensing equipment.
* Verify all breaker controls, annunciation, alarms and auxiliary equipment function as designed per manufacturer requirements and specifications
* Functionally test trip and close permissive circuits and interlocks
* Test/verify all auxiliary contact functions for breaker operation, motor operated disconnect, protective relaying, control, remote and local annunciation
* Time auxiliary contact used in breaker failure protection

**Annunciator**

* Verify that all inputs result in correct outputs per schematic/design documents by actuating initiating devices
Current Circuits

* Verify that ratio, polarity, and all secondary connections conform exactly to the three line current diagram
* Verify one ground per secondary circuit by removing the ground and testing insulation resistance at 500 volts DC. Minimum required value is 1 megohm.
* Verify all current shorting switches, bars and other shorting devices provide a continuous circuit when relays meters, etc. are removed from the circuit
* Test overall connection of secondary current circuits used for high voltage metering, control, and protection by means of primary current injection
* Test all polarizing current transformers and circuitry providing current to switchyard equipment by primary injection
* Measure total CT circuit DC resistance for all bus differential relay circuits as requested by EED

Potential Circuits

* Verify that ratio, polarity, and all secondary connections conform exactly to the three line potential diagram
* Verify one safety ground per circuit by removing the ground and checking circuit insulation resistance at 500 volts DC. Minimum value is 1 megohm.

Motor Operated Disconnect

* Verify open/close motor rotation, hand crank safety interlock, disconnect blades move simultaneously, blades make proper contact, and have specified ‘wipe’ in their saddles
* Verify manual stops are set
* Verify operation by hand crank
* Verify status and operation of all auxiliary contacts connected to the operator or switch linkage by functional test

Panel Meters and Transducers

* Verify equipment rating (correct CT & PT ratios used)
* Perform meter and transducer calibration at cardinal points
Protective Relays

* Perform all manufacturers recommended acceptance tests
* Apply relay setpoints as specified by design documents
* Verify all functions used and relay characteristics by application of voltage and/or current
* Plot the impedance characteristic of all mho type relays. Inverse time overcurrent relays require test at three points along the timing curve. Phase comparison type relays require a check of all timers, setpoints, sequence network output and an end-to-end alignment and dynamic coordination (satellite) test. EED will provide test support at remote EED owned terminals.
* Verify correct CT and PT ratios have been used
* Verify outputs (trip, transfer trip, reclose, alarm, annunciator input, initiate, etc.) of all protective devices

SCADA

* Supply and verify field cable to the remote control and indication equipment cabinet. Operation of all points will be verified by functional test. Switchyard installer will operate all required input devices and apply current/voltage to the inputs of transducers to produce outputs to prove SCADA at EED request.
* It is suggested that all field cables be terminated in the SCADA cabinet(s) by the switchyard installer using plastic hardware (screws and washers) to isolate the SCADA equipment until ready for test.

Automatic Throw-Over

* Perform an insulation test of all live parts and cable at 1,000 volts DC. Minimum value 1 megohm for equipment rated 480 volts or less.
* Verify operation by functional test
* Verify phasing of normal and reserve feeds
* Verify installation is per latest design documents
* Perform all manufacturers recommended tests
* Verify and record all control relay and timer settings
Battery and Charger

* Set charger float and equalize voltages
* Set over/under voltage, open battery detector, and ground detector alarms
* Perform receipt inspection of battery per manufacturer instructions
* Test insulation resistance of battery cable and distribution panels at 500 volts DC.
  Minimum value 1 megohm.
* Measure intercell resistance after connectors have been torqued
* Perform initial charge per manufacturer recommendation
* Measure and record cell voltage and specific gravity one week after completion of
  initial charge
* Measure and record cell terminal voltages monthly

Auxiliary power transformers

* Perform insulation resistance phase to ground and high voltage winding to low voltage
  winding
* Test windings rated 480 volts or less at 500 volts DC, windings rated above 480 volts at
  2500 volts DC.  Minimum insulation resistance for 480 volt rated equipment is 1
  megohm, over 480 volts is 1 megohm per kV plus 1 megohm.
* Perform a turns ratio test
* Set in service taps
* Verify output voltage and phasing

Control Circuits

* Verify that all control circuits conform to the latest revision of applicable control
  schematics.  IE, test individual contacts and logic strings by actuation of contacts.
* Verify that trip/close/initiate/annunciation and alarm signals are routed through
  test/isolation switches per schematic
* Verify the placement and operation of blocking diodes

Microwave Equipment

* Verify all connections conform to the latest revision of applicable design documents up
  to the demarcation cabinet

Fire Detection/Suppression

* Verify installation functions per the latest revision applicable design documents
Lifted Leads and Jumpers

* All lifted leads (cable conductors, wires) and temporary jumpers not shown on the design documents are numbered and tagged in the field
* All temporary control jumpers are constructed using #10 wire with red insulation. A log will be kept for all lifted leads and jumpers. The log will include the following data:
* Lifted lead or jumper number
* Panel number or physical location
* Schematic and wiring diagram affected
* Function of the jumper
* Reason for lifting the lead
* Name of the person performing the modification and company affiliation

Required “Through Fault Tests

A through fault test is an overall primary current injection test. It is not an actual fault test. Test currents obtained will be much lower than fault currents since the source voltage used for the test will be much less than actual system voltages. This test injects primary current into all three phases of the actual high voltage equipment. Through fault tests of high voltage busses or tap lines can be accomplished with very low voltage sources (120 or 240V may suffice). Through fault tests for line and transformer differential circuits may be combined into one test. For transformer tests, voltage may be connected on either the primary high voltage side or secondary high voltage side of the equipment as necessary to obtain a measurable amount of test current (examples of documented through fault tests can be provided by the testing group). All three phases of the side of the equipment that is not connected to the test voltage are shorted. The current injected will flow through primary side of all the CTs of the differential circuit under test. A through fault test of a transformer may connect a voltage source to the high side of a transformer at a point such that the current will flow through the high side transformer differential CTs. The transformer will be shorted on the low side such that the current will flow through that allow side transformer differential CTs. Monitoring during the test proves proper direction of currents in all differential relay elements. Measuring currents and phase angles at test switches for the differential relay circuit will do this. Another measurement method is to obtain proper metering and oscillographic information from a microprocessor based differential relay. In addition, this test also verifies the overall ratio of the transformer windings. Upon completion of a through fault test, a final circuit breaker trip test is done by injecting secondary current into a differential relay under test and tripping its lockout. Equipment is energized directly following completion and acceptance of these final overall tests.

**Warning**: Initial livening of high voltage circuits will not be allowed until all testing items including required through fault tests have been completed, witnessed and approved. Livening equipment without these tests will result in disconnection from the EED system.
Initial In-Service Tests

* The switchyard will be energized using written procedures supplied by the installer and approved by EED. The procedure and results of all installation testing will be supplied to EED at least fifteen working days in advance of livening.
* All protective relaying will be in service prior to energization. Any temporary modifications to the protective scheme must be approved by EED.
* Individual relay trips may be disabled after livening to facilitate testing. The procedure will energize the smallest amount of new equipment and allow for in service phasing tests, current and potential tests to verify the ratio, polarity, primary and secondary connections to all relays, test switches, transducers and meters.
* Magnitude and phase angle of secondary currents and voltages will be measured at all available locations
* Individual current transformers will be shorted to prove their contribution to schemes requiring multiple current inputs
* Individual potential devices will be grounded to verify broken delta secondary connections
* All initial in service tests must be witnessed by EED
* Perform in service test of all directional relays to verify connections provide the required tripping direction (Example, KD relay 6 of 9 test). For relays requiring residual current, the appropriate phase current transformers will be shorted and/or jumpered to force current through the residual elements.
* All data including system configuration, direction of system power flow, test equipment connection, method and test results will be recorded in detail sufficient to recreate the tests
* Potential inputs to all automatic synchronizing equipment and/or synchroscopes will be verified using primary voltage wherever possible
* Automatic close outputs and/or synchroscope indication also will be verified prior to connecting generation to the EED system

General Documentation

EED requires the following documentation:
  * Complete nameplate data for all equipment installed including manufacturer, make, model, serial number, instruction book/leaflet number, all applicable ratings (voltage, current, BIL, etc.)
  * One copy of all test results must include company affiliation of the test technician, date and signature of the test technician for each piece of equipment and control circuit installed, including the test method and equipment used
  * Include the applied voltage/current levels, megohm values, device operating temperatures, pressures, time delays, the date the test was performed, the signature and company affiliation of the person performing the test and the result of the test evaluation (pass/fail, acceptable, unacceptable) using ComEd supplied criteria
* Two copies of the manufacturer specifications, instruction manual and design
documents provided by the manufacturer for all equipment installed.
* Two copies of all final, current and correct as-built design documents (such as
schematic & wiring diagrams, key diagrams one lines, cable tabulation, structural and
physical drawings).
* Two copies of the design document index (T&DA only, not the total ComEd
requirement)
* Lifted lead and jumper log listing locations and reasons for lifted conductors or
temporary jumpers

Specific Documentation Requirements

Current Transformers

As shown on Field Reference Manual FRM VII-8 data sheets, pages 6 through 11 dated 7/1/96.

Potential Device

As shown on Field Reference Manual FRM VII-9 data sheets, pages 8 and 9 dated 7/1/96.
Power factor test results, method/equipment used to obtain the results.

Fire Detection/Suppression

Supply licensed contractor test results and certification that the installation meets all applicable
codes.

Control /Potential/Current Circuits

Schematic drawing number, revision number, and in instances where multiple circuits are shown
on one diagram, a description of the circuit. Date signature and company affiliation of the person
verifying field installation of each control circuit is complete and correct per the latest revision
of the schematic diagram. Signature indicates that test data for all equipment shown on the
schematic has been reviewed and is within manufactures and/or EED acceptance criteria. In all
instances where circuits have been altered or incomplete, (lifted leads or temporary jumpers), a
list of those alterations and incomplete items.

Battery/Charger

Float, equalize, ground alarm set points applied in the field. Cell voltages and specific gravities
after the initial on-site charge. Monthly report including pilot cell specific gravity, overall
battery voltage and a record of the dates and duration of equalizing charges.
Ground Grid

Grid resistance measurement and method of test. Written verification that all equipment and fencing is connected to their respective grids.

Circuit Breakers

Power factor test results, method/equipment used to obtain the results. Timing/synchronizing test results. All controls documented per Control /Potential/Current Circuits requirements. Current transformers as specified per current transformer documentation requirements. Process or data sheets used to record as-built mechanical tolerances/settings, temperature and pressure switch settings and timer settings.

Automatic Throwovers

Process or data sheets used to record as-left time delays and control relay set points.

Protective Relays:

For microprocessor relays a signed, dated print out from each relay listing all applied settings and installed software revision. For all other relays, a signed and dated copy of the relay setting order or equivalent design document showing the actual setting applied, electrical test results verifying the relay setpoints and relay operation. Data must include overall current and potential device ratios (including auxiliary transformers). Power Factor (Doble) Tests:

Record results on supplied forms or equivalent.

Chicago, IL 60603-0767

(312) 394-8338 (What about PECO)
Appendix 4 Approved Relays for Use on the EED System

The following is a partial list of relays that EED has approved. The intention of this list is to avoid the customer’s use of unapproved relays. However, using only approved relays does not take the place of submitting to EED for approval; the non-utility generation installation’s proposed list of relays and application including settings. Even an approved relay can be misapplied. To avoid problems, the customer needs to seek the relay manufacturer’s approval of the relay application before submitting the protection scheme to EED for approval. For relays EED has not tested, IEEE/ANSI C37.90 certified test reports by the manufacturer and independent laboratories should be submitted to EED along with the complete manufacturer instruction books and application guides for the relay model being used. Generally speaking, early and periodic exchange of information with EED is the best way to insure a successful project.

The appearance of a relay on the list is not a guarantee of the relay nor, does it constitute a recommendation of any relay application to protect the customer’s equipment. Nor does appearance on the list address software, firmware or hardware revisions. Any questions regarding the acceptability of a relay should be directed to the System Protection Department.

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APPENDIX 5 - EED IPP METERING REQUIREMENTS

PURPOSE
To provide guidelines for EED’s requirements for revenue metering at IPP facilities and includes registration of both generation output (wholesale) and auxiliary power (retail) service. For purposes of this document, revenue metering shall include the meter itself and any associated current transformers (CTs) and voltage transformers (VTs).

TERMS AND DEFINITIONS
CT: Current Transformer
EED: Exelon Energy Delivery
IPP: Independent Power Producer
RETAIL REVENUE METERING: All equipment involved for purposes to capture auxiliary power data to include meter(s), current transformers, potential transformers, communication and protection equipment.
TELEMETRY: Associated communication equipment with the metering.
UPS: Uninterruptible Power Source
VT: Voltage (Potential) Transformer
WHOLESALE REVENUE METERING: All equipment involved for purposes to capture generation data to include meter(s), current transformers, potential transformers, communication and protection equipment.

RESPONSIBILITIES
EED METERING DEPARTMENT
Provide guidance for Revenue Metering Requirements for Independent Power Producers (IPPs).

PRECAUTIONS
At some IPP facilities, auxiliary power is supplied from the same point of interconnection with the EED system to which the generation is connected, and the auxiliary power requirements are significantly less than the generation capacity of the facility. In such cases, the large ratio of the CTs needed to record the generation output may preclude the revenue metering from accurately registering the auxiliary power usage. For these reasons, EED requires separate revenue metering to measure auxiliary power usage at IPP facilities. Exceptions to this separate metering policy
may be warranted, as future technology improvements permit. Such exceptions will be at the sole discretion of EED Metering Department.

In order to register the net generation from the IPP facility to EED’s system, revenue grade metering equipment shall be required at each point of interconnection between the IPP facility and the EED system.

LIMITATIONS
The exact location of the wholesale revenue metering point(s) shall be determined on a site-by-site basis.

PREREQUISITES
All revenue meters to include wholesale and retail will be connected to an uninterruptible power (UPS) source for auxiliary power.

All revenue meters will have a provision to be read remotely via an AMR (Automatic Meter Reading) system. EED Metering Department shall be consulted for a dedicated communication source(s) such as phone circuits. The number and type of dedicated communication source(s) shall be determined on a site-by-site basis.

WHOLESALE REVENUE METERING
In order to register the net generation from the IPP facility to EED’s system, revenue grade metering equipment SHALL be required at each point of interconnection between the IPP facility AND the EED system.

Wholesale generation SHALL be METERED at the interconnection voltage.

The CTs AND VTs associated with the wholesale revenue meter(s) SHALL be ORIENTED AND CONNECTED such that power delivered from the EED system to the IPP facility is registered by the revenue meter as forward (positive) power flow.

Wholesale revenue meters SHALL have provisions for being READ remotely by EED. Additionally, usage data registered by the wholesale revenue meter(s) SHALL be TELEMETERED to EED’s operation facilities for the following purposes:

System control;
Monitoring of wholesale power transactions;
Transmission and distribution system operation;
Transmission related bill calculations; and/or Public safety
The exact location of the wholesale revenue metering point(s) SHALL be determined on a site-by-site basis.

**RETAIL REVENUE METERING**

In order to register the auxiliary power usage of the IPP facility, revenue grade metering equipment SHALL be required on the low voltage (secondary) side of the facility’s main power transformers, at a voltage consistent with standard EED metering voltages. These meters SHALL be LOCATED electrically such that they only register the auxiliary power usage, not the generator output. This may require the metering to be INSTALLED on the secondary side of the facility’s auxiliary power transformer(s).

The CTs AND VTs associated with the retail revenue meter(s) SHALL be ORIENTED AND CONNECTED such that power delivered from EED system to the IPP facility is REGISTERED by the revenue meter as forward (positive) power flow.

The exact location AND number of auxiliary power metering points will be DETERMINED on a site-by-site basis.

Telemetry of usage data from the retail revenue meter(s) may be required when situations exist that involve self-supply by the IPP. Such requirements will be determined on a site-by-site basis AND SHALL be the sole discretion of EED.
APPENDIX 6 - TELEMETRY STANDARDS

General Design Requirements

There are three concerns with telemetry at GIC sites:

- The normal requirements for substation remote supervision and operation.
- The unique requirements for GIC service, as emphasized in this document.
- PJM requirements

At small sites, a single SCADA RTU can typically satisfy the design requirements. At larger sites, an RTU will be dedicated to GIC requirements, and additional devices will be installed as needed for substation supervision and operation.

When telemetry is required, as described earlier in this document, the following design will be used.

- The GIC will provide a SCADA RTU for the site per EED Specifications. The RTU will require a data communications circuit as specified by EED. This will most likely be a permanent 4-wire analog or digital telephone line to EED System Operations office. The PJM SCADA connection (if required) will require an always on commercial Internet service.
- For the RTU to acquire data from the revenue meter(s) at the site, please consult EED for method of communication.
- Usually the RTU will also need to receive data from the GIC (for example, status of each generator circuit breaker). The GIC data can be most efficiently supplied to the RTU over a serial data-link from the GIC control system (PLC, DCS, etc.). This data-link is bi-directional and can provide the GIC with access to revenue meter data. Usually the data-link makes use of Modbus protocol with GIC acting as Modbus master. DNP3.0 protocol is also supported.

Base Equipment

SCADA Remote Terminal Unit (RTU)
Revenue Meter
Permanent Data Circuit (Most likely a 4-wire leased analog or digital telephone circuit)

Option for RS232 data-link to GIC (less than 100 feet)
RS232 cable

Option for Fiber/Optic data-link to GIC (over 100 feet)
Dymec F/O transceiver at RTU
Dymec F/O transceiver at GIC
Fiber optic cable with accessories (“ST” connections at each end.)
APPENDIX 7 – REAL ESTATE REQUIREMENTS (When Required)

It is the GIC's responsibility to purchase property, acquire rights and obtain any required permits for the T&D lines requiring an EED owned and maintained interconnect substation for its generation. Most small generator installations will not require this type of substation and the required equipment will be owned and maintained by the customer on his property. In addition, the Interconnection Agreement will require that the GIC grant to EED such rights and interests as may be reasonably necessary to interconnect the generation station to the EED System. Real estate transactions will be determined by the type of interconnection configuration employed, which may include:

- Conveyance of fee simple ownership to EED for the construction of a switchyard.
- Conveyance of perpetual easements (exclusive and nonexclusive) associated with the switchyard including, but not limited to, access, drainage, and such overhead and underground facilities as EED may reasonably require for the construction, use, maintenance and operation of the switchyard.
- Conveyance of perpetual transmission and facilities easements (exclusive and nonexclusive) for all purposes of interconnecting the generation station with the EED transmission system, including such overhead and underground electrical and related communications, transmission and distribution facilities.

In each of the three transaction scenarios outlined above, or any combination thereof, the GIC will be responsible for executing and delivering all documentation requested by EED, which may include deeds, easements, purchase agreements, assignments, affidavits, certifications, statements and releases, and for providing a title policy covering the rights and interests conveyed.

EED will grant to the GIC, subject to engineering review and approval, easement rights or consent, as applicable, for:

- Perpendicular crossings of EED transmission right of way to accommodate facilities such as roadways and various utilities, including natural gas and water pipelines and storm sewers.
- Longitudinal occupations of EED transmission right of way to accommodate pipeline facilities.
EED's Scope

EED will provide the following:

- Real estate forms of agreement, which incorporate terms and conditions that reflect EED's standard business practices.
  - Engineering review of proposed GIC facilities that involve EED real estate and/or right of way.

GIC's Scope

It is imperative, when the GIC is required by the scope of a project to provide information, that the deliverables itemized below be received by EED as soon as possible. This will facilitate a timely review and will allow EED to address the real estate aspects of the project in a timely manner.

The GIC is responsible for providing the following:

- The following current information covering all interests and rights to be conveyed to EED:

  1. Title Policy/Commitment.
  2. Copies of all recorded documents listed in above-mentioned Title Policy/Commitment.
  3. ALTA/ACSM Land Title Survey, which will include adjoining Exelon property, if applicable.
  4. Topographic survey at a contour interval appropriate to the relief and size of the property.
  5. Phase I Environmental Assessment Report (Phase 2 if appropriate) and any other environmental reports, notifications and documents.
  6. Wetland Delineation reports.
  7. Annexation Agreement(s), zoning changes or other governmental agreements or approvals entered into or proposed.
  8. All jurisdictional permits, such as special use and building permits, that have been issued for the project or copies of pending applications that relate to or affect property in which EED has or will have a right or interest.
9. Detailed civil engineering drawings showing the proposed site plan, layout, drainage, access and facilities.

Additional information may also be required, depending on project requirements. Requests for such information will be transmitted to the GIC during project development.
APPENDIX 8 - INTERCONNECTION SUBSTATION DESIGN STANDARDS (When Required)

Introduction
This appendix provides substation design information for interconnection with the EED Transmission system. Use the Interconnection Configuration Table and associated drawings as a guide to determine equipment requirements and ownership. All design documents and equipment specifications should be approved by the EED in collaboration with PJM prior to equipment purchase and construction activities. EED will inspect and approve the installation in accordance with the PJM Tariff before the equipment is energized.

Based on the design required for the interconnection, EED in collaboration with PJM will require that either a GIC owned substation be built with provisions for EED owned equipment (the EED owned equipment is that equipment located in the GIC’s facility and is needed to interface to the EED system) or a separate EED substation be built. The GIC will be responsible for the cost of engineering, procurement of equipment, installation of equipment and associated supporting devices and the testing of the EED owned equipment unless to the extent that it exercises the option to build. EED, in collaboration with PJM, will supply all requirements, approve all engineering documents and witness the testing of the equipment. Ownership of the facility will be in accordance with the PJM Tariff.

Substation Requirements
Note: The following covers the majority of the requirements and installations. Any specialized requirements based on the project will be the GIC’s responsibility to resolve including the engineering, procurement, installation and testing.

Control Building requirements
The GIC is responsible for his own building. EED will require that a space be allocated for the use of EED's equipment that requires protection from the environment. The estimate space is 25’ by 25’. The space will only be accessible to EED personnel on a 24 hour, 7-day basis. The GIC is responsible for supplying and maintaining HVAC, ventilation, and AC power. The GIC will design the room based on EED's reasonable requirements specified prior to execution of and as stated in the ISA/CSA and perform all construction activities to meet these requirements.

Transmission Line Dead-End Structure
The GIC will supply and own the structure and foundations where EED will dead-end or terminate its transmission conductors. EED will supply the insulators at the GIC’s expense. The GIC shall supply the associated hardware for the transmission line connection. The GIC’s dead-end structure will meet EED's specifications based on system voltage and terrain requirements.

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**Transformers**

Before ordering the GIC owned transformer, the GIC must submit the transformer nameplate data to EED and PJM for approval, because the normal operating voltage in some parts of the system may deviate slightly from the nominal voltages. EED recommends purchasing transformers with a high-side, nominal center tap, with two taps above and two taps below, each at 2.5 percent of the nominal voltage. Approval by EED does not imply warranties or endorsement. If EED were to upgrade its facilities, it becomes the GIC’s responsibility, subject to Section 53 of the PJM Tariff, to maintain compatibility between the GIC’s and EED’s System. The EED project diagram will show the necessary transformer connections for interconnecting to the EED system.

**Lightning Arrestors and Lightning Strike Protection**

If the GIC chooses to install lightning arrestors, the arrestors would be located on the transformer side of the fault-interrupting device.

EED requires that all equipment rated 138kV or higher be shielded from lightning strikes. EED recommends that the GIC install lightning stroke protection for all high voltage equipment.

The GIC is responsible to engineer, procure, and install all lightning stroke equipment.

**Fault Interrupting Devices**

Fault-interrupting device needs to have sufficient capacity to interrupt the maximum available fault current at its location. EED will provide the GIC the fault duty values upon request. The fault duty available at a specific location on the EED system is subject to and is likely to change at any time.

Three basic types of fault-interrupting devices are:

- Circuit Breakers
- Circuit Switchers
- Fuses

**Circuit Breakers.** A three-phase circuit breaker at the point of interconnection automatically separates the GIC’s equipment from the EED system when a circuit fault is detected. Additional breakers may be installed in the GIC’s equipment to facilitate operating and protecting the GIC facility.

The GIC owned Circuit Breakers should be equipped with the following:

- Tripcoil to trip the breaker with an external trip signal supplied through a battery
- Two trip coils are required on the line circuit breaker.
- Telemeter the breaker status to EED's Bulk Power Operations
- Lock out if operated by protective relays is required for the line breakers
**Circuit Switchers**
A circuit switcher is a three-phase fault interrupter with limited fault interrupting capability at 69kV or 138kV.
The fault duty available at a specific location on the EED system is subject to and is likely to change at any time.
Subject to PJM’s approval pursuant to Section 82.1.2 of the PJM Tariff, these devices may be substituted for circuit breakers if the fault duty is within the interrupting rating of the circuit switcher. Circuit switchers with blades can double as the visual open disconnect switch (subject to EED approval). Because circuit switchers do not have integral current transformers, they need to be installed within 30 feet of the associated current transformers to minimize the length of the unprotected line/bus section.
Circuit switchers should be equipped with the following:
- Tripcoil to trip the circuit switcher with an external trip signal supplied through a battery
- Telemeter the status to EED's Bulk Power Operations
- Lock out if operated by protective relays required for interconnection.

**High Voltage Switches**
Two types of switches are:
- Disconnects (manual or motor operated)
- Line sectionalizing switches

**Disconnects (Manual or Motor Operated).** The primary disconnect device should be at the point of interconnection with EED. This device would be operated by EED and is used to establish a visually open working clearance for maintenance and repair work in accordance with EED safety rules and practices. The disconnect device should not be used to make or break parallels between the EED system and the GIC’s substation. It should be a gang-operated, three-pole switch. The device shall be manually operated. The device enclosure and operating handle (when present) shall be kept locked at all times by EED.

The device shall be physically located for ease of access and visibility to EED personnel. When installed in the GIC’s substation, the device shall normally be located close to the metering. The EED operated disconnect shall be identified with a EED designated switch number plate.

Disconnect devices must have the following specifications:
- Should be rated for the voltage and current requirements of the particular installation
- Should be gang-operated
- Should be weatherproof
- The first disconnect switch, at the point of ownership change, should be lockable in both the open and closed positions with a standard EED lock
**Line Sectionalizing Switches.** Line sectionalizing switches may be installed on one or both sides of a single-tap in order to provide operational flexibility in providing service to customers on the tap line. They are used to reduce the duration of customer outages for planned maintenance in the main line and to restore service when an unplanned interruption occurs on the main line. A sectionalizing switch may not be required if the distance from the new single-tap interconnection to either end of the transmission line or to an existing sectionalizing switch on the line is relatively short.

**Miscellaneous High Voltage equipment**

Miscellaneous equipment such as CCVT’s, PT’s, CT’s, Wave Traps, Carrier Current, etc. will be required and owned by EED. EED and the PJM will specify this equipment as the project develops. The GIC will be responsible to engineer, procure, install and test this equipment.

**Foundations and Structures**

All foundations and structures are the responsibility of the GIC to engineer, procure, install, and maintain. Those foundations and structures that are used to support EED owned equipment must be built to EED standards in collaboration with PJM.

**Grounding**

The GIC is responsible for the specification, procurement, design, installation and serviceability testing for all grounding systems installed for equipment in the generating facility and all EED owned equipment located on GIC property. The GIC will have to install a ground system that meets the current grounding requirements of EED. This will include the overall ground grid resistance, potential rise, touch potentials and step potentials. The GIC will have to provide EED, in collaboration with PJM, calculations and soil resistively test data prior to the installation of the ground system for approval by EED’s Ground System Specialist. Current ground system requirements will be provided to the GIC at the start of the project.

**AC and DC Auxiliary Power**

The GIC is responsible for the specification, design, procurement, installation, and testing of all GIC owned AC and DC auxiliary power systems.

EED will require an uninterruptible source of AC Power from the GIC and it’s own dedicated DC auxiliary power system. The EED DC auxiliary power system will be totally located in the EED control room. EED, in collaboration with PJM will specify, the project requirements. The GIC will be responsible for engineering, procurement, installation and testing of both systems.

**Control Cables**

EED will collaborate to coordinate the activities required to install all control and instrument cables that will run between the EED control building and the generating facility. They will terminate at a pass-through interconnection terminal block cabinet to be located in the EED control building. This interconnection cabinet will be designed, furnished and installed by the
GIC. Any shielded cables involved will have their shields grounded at the receiving end only and the shields will be “carried through” the interconnection cabinet on terminal block points.

All control and instrument control cables that will run between the EED control building and the outdoor EED owned equipment will be installed in approved buried conduit or cable trough systems.

The GIC will be responsible for engineering, procurement, installation and testing of all cables and associated control systems.

**Telephone Protection Cabinet (if required) and Telephone Circuits**

EED will provide the GIC a list of required phone circuits to be installed in the EED control building. Installation of phone circuits will be done at the GIC’s expense.

The GIC and the telephone provider are responsible for determining if a telephone protection cabinet is required in the EED control building. The GIC and the telephone provider will specify, furnish, and install required protection equipment in/on a suitable wall mounted panel or cabinet to be designed, supplied and installed by the GIC. EED will supply additional specifications to be used with the specifications provided by the telephone provider.

The GIC is responsible for contacting the telephone provider to determine whether telephone equipment located at the generation facility needs circuit protection equipment installed.

**Data that the GIC Furnishes to EED**

- Plot plan showing proposed substation location and proposed access road
- Grading plan of proposed substation, access road, and adjacent areas
- Soil report or suitable information for foundation design
- Electrical plans such as single-line meter and relay drawings, general arrangement of conduits and grounds and elementary diagrams of GIC’s facility. These drawings will include all high voltage fuse and or breaker ratings, capabilities of interrupting devices, current transformer and potential transformer ratios and connections, and protective relay types, range and settings. All drawings that EED requires must be submitted in AutoCAD R2002 format, and must follow the EED Design Drafting Guidelines, available on request.
- Substation equipment specifications and layout
- Arrangement and requirements for foundations, embedded stubs, and anchor bolts
- Arrangement of conduits (if required) and grounds
- Electrical data such as short circuit duty, transformer impedance, etc.
- Engineering standards for substation fence and fence grounding
- Relay coordination and other protection requirements

**Substation requirements for EED owned substation**

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The GIC is required to build a high voltage substation located adjacent to the generating facility. This substation will be built at the GICs expense and turned over to EED prior to being energized. The legal matters regarding this turn over are covered in other sections of this manual along with various documents that must be submitted as the project progresses.

The entire engineering, equipment and land procurement, installation and testing of the substation are the GICs responsibility. If this is on the EED side of the point of interconnection, EED must design and build unless the GIC elects the option to build. EED in collaboration with PJM must approve all documents and equipment specifications prior to any construction or material orders. (See PJM Tariff 82.1.2 – on the option to build)

The following is a condensed list of requirements but is not necessarily all-inclusive. It is only meant to give a developer a rough idea for initial budgetary purposes. EED in collaboration with PJM will specify the project requirements.

- Fenced in substation yard to accommodate the control building, high voltage equipment and a perimeter road for truck access and maintenance.
- Control building 30’ x 80’ (approximate) with the following equipment:
  - HVAC
  - Relay Panels
  - One or two DC Systems (depends on high voltage requirements)
  - ATO with two AC Sources
  - AC panels
  - Lighting
  - Security
  - Scada
  - Digital Fault Recorder
  - Fire Detection
  - Storage area
  - Ground system
  - Revenue metering cabinet
  - Fiber Optic splice boxes and jumper cables to meet relaying requirements

- Switchyard Requirements
  - Two Auxiliary Power Transformers feed from remote EED sources
  - Ground system
  - Lightning stroke protection and arresters
  - High voltage circuit breakers
    - SF-6 Dead tank for 230kV or lower
    - SF-6 Live Tank for 345kV or higher
  - Maintenance disconnects on each side of circuit breakers
  - Free standing 345kV (or 500 kV as applicable) five core CT’s for each 345kV (or 500 kV) circuit Breaker as applicable
  - Motor Operated Disconnect for each line position if on ring bus
  - CCVT’s or PT’s to meet relaying requirements
  - Carrier Current equipment and wave traps to meet relaying requirements
  - Revenue Metering Equipment
  - Microwave tower to meet relaying requirements
  - Fiber Optic cables to EED Transmission system and/or to GIC’s generating facility to meet relaying requirements
  - Transmission Line Dead-End Structures
  - Foundations
  - Roads
  - Water Detention/Retention and drainage

**Substation requirements for work required at existing EED owned substations**

Unless the Interconnection GIC exercises the option to build under PJM Tariff 83.2.3 all upgrades or additions required at existing EED owned substations will be done by EED or a
designated alternate. EED will engineer, procure equipment, install and test the equipment at the GIC’s expense per the PJM Tariff.

These changes could be a minor relay modification or a major bus addition. Each project is site dependent and could involve several substations. The Interconnection Studies, the ISA and the CSA for the project will define the requirements.
APPENDIX 9 - TRANSMISSION STANDARDS

Introduction

This appendix provides guidelines and minimum requirements for design of a generator’s or customer’s transmission line(s) intended to be interconnected with Exelon Energy Delivery’s (EED’s) own transmission line(s) or substation. Transmission lines are defined by EED as electric supply lines energized at 69 kV and above (nominal, rms, phase-to-phase voltage), overhead and/or underground. Exelon’s electric transmission systems are currently owned and operated by EED’s utility companies - ComEd and PECO (in their respective operating areas). Existing transmission line voltages on EED’s transmission systems are as shown in Table 5-1, below.

<table>
<thead>
<tr>
<th>Nominal Line Voltage (rms kV)</th>
<th>Maximum Phase-to-Phase Voltage (rms kV)</th>
<th>Maximum Phase-to-Ground Voltage (rms kV)</th>
<th>Exelon Company(s) Owning Transmission Lines of this Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>72.5</td>
<td>41.9</td>
<td>ComEd and PECO</td>
</tr>
<tr>
<td>138</td>
<td>145</td>
<td>83.7</td>
<td>ComEd and PECO</td>
</tr>
<tr>
<td>230</td>
<td>242</td>
<td>140</td>
<td>PECO</td>
</tr>
<tr>
<td>345</td>
<td>362</td>
<td>209</td>
<td>ComEd</td>
</tr>
<tr>
<td>500</td>
<td>550</td>
<td>318</td>
<td>PECO*</td>
</tr>
<tr>
<td>765</td>
<td>803</td>
<td>464</td>
<td>ComEd*</td>
</tr>
</tbody>
</table>

*Overhead lines only

Generally speaking, generators connecting to ComEd’s transmission system will be connected to either 138 kV or 345 kV overhead lines and generators connecting to the PECO transmission system will be connected to either 230 kV or 500 kV overhead lines.

EED transmission lines generally occupy private or railroad rights-of-way. Tubular steel structures with concrete foundations are typically used for construction of new EED overhead transmission lines. The latest standard EED overhead conductors are shown in Table 5-2, below. High capacity 230 kV lines will generally have a bundle of two 1590 kcmil ACSR conductors per phase. High capacity 345 kV lines will generally either have a bundle of two 1277 kcmil ACAR conductors per phase or a single 2226 kcmil ACSR/TW conductor per phase. A bundle of two 2493 kcmil ACAR conductors is used for 500 kV lines. Current standard EED overhead ground/static wires are 7-#5 aluminum-clad steel and 19-#9 aluminum-clad steel. EED overhead transmission lines typically use standard ceramic ball & socket insulators and standard line hardware in suspension and dead-end applications. Non-ceramic, Silicone rubber post and braced post insulators are typically used for jumper support applications and compact construction, respectively, in the 69 kV through 345 kV voltage classes.
New EED underground transmission lines are typically built with solid dielectric cables in ducts in the 69kV, 138 kV, 230kV, and 345kV voltage classes.

Engineering drawings, catalog cut sheets, and informational sheets describing all major transmission line components --- structures, conductors, overhead ground/static wires, insulators and hardware, grounding materials, and switches (if required) --- should be approved by EED, in collaboration with PJM engineers, prior to purchase by the GIC. Refer to the section below entitled Minimum Design Requirements for specific design requirements. The Interconnection Customer shall furnish drawings, documents, and calculations with adequate time for EED to review and comment on the adherence to these requirements.

General Comments Related to a Transmission Interconnection

Except to the extent that the Interconnection Customer exercises the option to build, EED will design, construct, own, and maintain all transmission facilities between EED’s existing transmission system and the Point of Interconnection with the generator or customer. The Point of Interconnection is typically a manually-operated, air-break disconnect switch located on the generator’s or customer’s property immediately adjacent to existing or proposed EED transmission facilities or a terminal structure in an EED-owned substation. When, by mutual agreement, the Interconnection Customer is designated to design and build transmission line facilities that would be turned over to be owned, operated, and maintained by EED, the facilities shall be designed and built per EED standards.

It is the Interconnection Customer’s responsibility to purchase the property and obtain any required permits for the transmission line or lines required to interconnect his generator or facilities and the Point(s) of Interconnection. The customer may expedite the transmission interconnection process by obtaining the transmission right-of-way for EED’s portion of the interconnecting transmission facilities, as well as for his own.

EED’s overhead transmission circuits will have various maximum electrical load limits, depending on conductor type and size, available clearances, hardware & accessories, location, rating assumptions, etc. Conductor thermal ratings are based on computed conductor temperatures under assumed ambient (wind, temperature, atmospheric, and solar radiation) conditions, conductor properties, and geographic location. Thermal ratings should limit conductor temperatures such that all of the following conditions are satisfied:

a) corresponding sags do not violate clearance limitations,

b) corresponding loss of strength of the conductor over its expected life will not exceed that which has been allowed for in the line’s design, and

c) conductor splices, clamps, hardware, fittings, etc. do not suffer intolerable loss of strength and/or operability.

Situations may arise where limitations other than the thermal rating of the conductor will limit the maximum rating of a circuit (e.g., substation equipment ratings, legal or contractual limitations relating to magnetic field strengths, inductive interference limits on adjacent facilities, etc.)

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Contemporary (recently-designed) EED overhead lines will typically have one of the standard conductor sizes (with typical electrical loading limits) shown in Table 5-2, below.
### Table 5-2, Contemporary Standard EED Overhead Transmission Line Conductors and Associated Typical Electrical Ratings in Amperes

<table>
<thead>
<tr>
<th>Nominal Line Voltage (kV)</th>
<th>Cond. Type</th>
<th>Size (kcmil)</th>
<th>Strands (outer / core)</th>
<th>Code Word</th>
<th>Summer Rating (Amps)</th>
<th>Winter Rating (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Normal 7</td>
<td>Emerg. 8</td>
</tr>
<tr>
<td>69, 138 (C)</td>
<td>ACSR</td>
<td>477.0</td>
<td>26/7</td>
<td>Hawk</td>
<td>875</td>
<td>1090</td>
</tr>
<tr>
<td>69, 138 (E)</td>
<td>ACSR</td>
<td>477.0</td>
<td>30/7</td>
<td>Hen</td>
<td>880 (C)</td>
<td>1110 (C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>806 (P)</td>
<td>1038 (P)</td>
</tr>
<tr>
<td>69, 138 (C)</td>
<td>ACSR</td>
<td>636.0</td>
<td>24/7</td>
<td>Rook</td>
<td>1045</td>
<td>1325</td>
</tr>
<tr>
<td>69, 138, 230 (P)</td>
<td>ACSR</td>
<td>795.0</td>
<td>26/7</td>
<td>Drake</td>
<td>1155</td>
<td>1418</td>
</tr>
<tr>
<td>69, 138, 230 (P)</td>
<td>ACSR</td>
<td>795.0</td>
<td>30/19</td>
<td>Mallard</td>
<td>1168</td>
<td>1431</td>
</tr>
<tr>
<td>69, 138, 345 (C)</td>
<td>ACSR/TP</td>
<td>954.0 ³</td>
<td>26/7</td>
<td>Hawk/TP</td>
<td>1436</td>
<td>1841</td>
</tr>
<tr>
<td>69, 138, 230 (P)</td>
<td>ACSR</td>
<td>1033.5</td>
<td>54/7</td>
<td>Curlew</td>
<td>1369</td>
<td>1662</td>
</tr>
<tr>
<td>69, 138, 345 (C)</td>
<td>ACSR/TP</td>
<td>1033.5 ³</td>
<td>21/7</td>
<td>Curlew²</td>
<td>2518</td>
<td>2518</td>
</tr>
<tr>
<td>69, 138, 345 (C)</td>
<td>ACSR</td>
<td>1113.0 ³</td>
<td>45/7</td>
<td>Bluejay</td>
<td>1470</td>
<td>1860</td>
</tr>
<tr>
<td>69, 138, 345 (C)</td>
<td>ACSR/TP</td>
<td>1113.0 ³</td>
<td>24/7</td>
<td>Parakeet/TP</td>
<td>1655</td>
<td>2130</td>
</tr>
<tr>
<td>All (C)</td>
<td>ACAR</td>
<td>1277.0 ³</td>
<td>54/7</td>
<td>N/A</td>
<td>1440</td>
<td>1770</td>
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<tr>
<td>All (P)</td>
<td>ACSR</td>
<td>1590.0 ³</td>
<td>54/19</td>
<td>Falcon</td>
<td>1845</td>
<td>2192</td>
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<tr>
<td>345 (C)</td>
<td>ACSR</td>
<td>2156.0</td>
<td>84/19</td>
<td>Bluebird</td>
<td>2270</td>
<td>2910</td>
</tr>
<tr>
<td>345 (C)</td>
<td>ACSS</td>
<td>2156.0</td>
<td>84/19</td>
<td>Bluebird²</td>
<td>4195</td>
<td>4195</td>
</tr>
<tr>
<td>345 (C)</td>
<td>ACSR/TP</td>
<td>2226.0</td>
<td>45/7</td>
<td>Bluejay/TP</td>
<td>2570</td>
<td>3335</td>
</tr>
<tr>
<td>All (P)</td>
<td>ACAR</td>
<td>2493.0 ⁴</td>
<td>54/37</td>
<td>N/A</td>
<td>1907</td>
<td>2324</td>
</tr>
</tbody>
</table>

Notes to Table 5-2, Standard EED Conductors:

1. (C) = ComEd standard; (P) = PECO standard; (E) = Common EED standard (i.e., both EED systems)
2. ACSR equivalent codeword
3. Use of this conductor at 345kV and above requires bundled phase construction. (Ratings shown in Table 5-2 are per sub-conductor.)
4. Use of this conductor at 500kV and above requires bundled phase construction. (Ratings shown in Table 5-2 are per sub-conductor.)
5. Electrical ratings shown in Table 5-2 are provided only to indicate typical conductor thermal rating values for various EED transmission conductor sizes, developed using commercial rating software. Actual circuit ratings may vary from those shown in the table.
6. Summer ratings reflect an assumed ambient temperature of 35°C (95°F). Winter ratings reflect an assumed ambient temperature of 10°C (50°F).

Notes to Table 5-2, Standard EED Conductors, (Cont’d.):
7. Normal ratings are upper limits for normal, continuous operation. Emergency ratings are used for infrequent, short-term operation during emergency conditions. Wind speed assumptions relating to the Normal and Emergency ratings shown in table 5-2 are:

<table>
<thead>
<tr>
<th>Transmission System</th>
<th>Assumed Wind Speed (feet/second)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal Conditions</td>
</tr>
<tr>
<td>ComEd</td>
<td>4</td>
</tr>
<tr>
<td>PECO</td>
<td>0</td>
</tr>
</tbody>
</table>

Contemporary (recently-designed) EED underground lines will typically have one of the standard cable sizes shown in Table 5-3, below.

<table>
<thead>
<tr>
<th>Nominal Line Voltage (kV)</th>
<th>Cable Sizes (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>500 or 800</td>
</tr>
<tr>
<td>138</td>
<td>800 or 1600</td>
</tr>
<tr>
<td>230</td>
<td>1600</td>
</tr>
<tr>
<td>345</td>
<td>1600</td>
</tr>
</tbody>
</table>

*Minimum Design Requirements*

The generator or customer is to design, construct, own and maintain the transmission line or lines from his generator or facilities to the Point(s) of Interconnection. He is to design, specify, procure, install, and operate his transmission line(s) based on applicable industry codes and standards published by the ANSI, ASCE, AISC, ACI, IEEE, OSHA, ASTM and EEI, and in accordance with all applicable state and local laws and regulations. As a minimum, the line(s) shall meet all requirements of the latest edition of the National Electrical Safety Code (NESC). In addition, the line(s) shall be designed to meet the following EED minimum requirements:

1. Transmission line(s) shall meet the minimum electrical insulation design requirements as shown in Table 5-4, below:
Table 5-4, Minimum Transmission Line Insulation Requirements and Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Nominal Line Voltage (kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>69</td>
</tr>
<tr>
<td>Minimum Number of Ceramic Ball &amp; Socket Insulators/String</td>
<td>5</td>
</tr>
<tr>
<td>Min. Leakage Distance of Insulators, inches</td>
<td>42</td>
</tr>
<tr>
<td>Min. 60 Hz. Wet Flashover of Insulation</td>
<td>215 kV</td>
</tr>
<tr>
<td>Min. Negative Critical Impulse Flashover of Insulation</td>
<td>495 kV</td>
</tr>
<tr>
<td>Min. Air Gap Clearances to Structure for 60 Hz Voltage</td>
<td>0.7</td>
</tr>
<tr>
<td>Min. Air Gap Clearances to Structure for Switching Impulses</td>
<td>1.3</td>
</tr>
<tr>
<td>Switching Impulse Voltage Factors for Design</td>
<td>3.0 P.U</td>
</tr>
</tbody>
</table>

2. Transmission line(s) shall meet the minimum lightning performance requirements as shown in Table 5-5, below:

Table 5-5, Minimum Transmission Line Lightning Performance-Design Requirements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Nominal Line Voltage (kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>69</td>
</tr>
<tr>
<td>Approximate Lightning Ground Flash Densities</td>
<td>ComEd 4 strikes/ km²/year (= 10 strikes/ mi²/year)</td>
</tr>
<tr>
<td>Target Maximum Structure Footing Ground Resistance</td>
<td>ComEd 10</td>
</tr>
<tr>
<td></td>
<td>PECO 25</td>
</tr>
<tr>
<td>Maximum Allowable Shielding Angles</td>
<td>ComEd 0° (See Note 1, Below)</td>
</tr>
<tr>
<td></td>
<td>PECO 15° (See Note 1, Below)</td>
</tr>
<tr>
<td>Minimum Number of Static Wires Required</td>
<td>ComEd 1 Per Circuit (See Note 1, Below)</td>
</tr>
<tr>
<td></td>
<td>PECO 1 Per Structure</td>
</tr>
<tr>
<td>Note 1. Short structures in taps less than 300 feet in length and short structures/ spans of conductor that are effectively shielded against direct lightning strikes by taller adjacent structures or wires, trees, or natural terrain features may have fewer static wires and/or a larger shielding angles as long as the circuit as a whole meets the target lightning outage performance rates shown below.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Target Lightning Outage Rates (Number of Outages per 100 Circuit Miles per Year)</th>
<th>ComEd</th>
<th>PECO</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0 or less</td>
<td>1.0 or less</td>
<td></td>
</tr>
<tr>
<td>2.0 or less</td>
<td>1.0 or less</td>
<td></td>
</tr>
</tbody>
</table>

3. Transmission line(s) shall be designed to provide at least the minimum horizontal and vertical clearances over ground or obstacles under or near the line as required by the NESC, with appropriate margins of safety added to account for tolerances and uncertainties. In addition, the line(s) shall be designed to allow the generator/customer and/or his contractors to carry out their normal inspection and maintenance operations in the vicinity of the energized lines and still meet all applicable OSHA working clearance requirements. Required vertical clearances shall be provided under the maximum anticipated conductor sag conditions (i.e., with the conductors at Original 10-31-2006
their maximum design operating temperatures or under the ice loading condition prescribed in the NESC, whichever is greater).

4. Transmission line(s) shall be designed to withstand the ice and wind conditions with material strength reduction and overload factors as defined in the latest edition of the NESC and shall also be designed to withstand the structural loads as specified in American Society of Civil Engineers (ASCE) Manual and Report on Engineering Practice No. 74, “Guidelines for Electrical Transmission Line Structural Loading.” The generator/customer shall furnish drawings, documents and calculations in accordance with section 82.1.2 of the PJM Tariff for review for compliance with these regulations.

5. Details concerning the overhead ground/static wire and/or grounding interconnections, the electrical phasing, and the mechanical loading, geometry of the points of attachment, spacing, location and orientation of the structure(s) at the Point(s) of Interconnection will be determined on a project-specific basis in PJM’s interconnection studies.

**General Information and Guidelines**

For the EED portion of the transmission line interconnection, EED is responsible for the following general items:

* Transmission line engineering and design, including obtaining survey data between the existing EED transmission facilities and the Point(s) of Interconnection. The generator/customer may expedite the overall engineering process if he obtains the required topographic survey data for EED’s line design in conjunction with his own work at the site.

* For ComEd transmission lines: Obtaining the Certificate of Public Convenience and Necessity from the Illinois Commerce Commission (ICC) to install and modify the ComEd transmission facilities between the existing ComEd facilities and the Point(s) of Interconnection. For PECO transmission lines: Obtaining the Pennsylvania Public Utility Commission (PUC) approval to install and modify the existing PECO transmission facilities between the existing PECO facilities and the Point(s) of Interconnection. This includes preparing all drawings, documents, and testimony necessary to support the ICC or PUC application. Siting of the EED transmission line right(s)-of-way to the Point(s) of Interconnection must be mutually agreeable in order to support EED testimony to the ICC or PUC. The cost difference between the siting agreed to by the parties and the least cost alternative shall be paid by the generator/customer.

* Obtaining all necessary environmental permits and permits for transmission line crossings of roads, railroads and pipelines, as well as coordinating for access, locating of underground facilities, and obtaining insurance necessary for construction.

* All contractor inspection and construction supervision.
When overhead transmission facilities are required, EED is also responsible for the following general items on its own line(s):

* Procurement of poles, anchor bolts (if required), insulators and hardware, wires, switches (if required), grounding materials, and other accessories.

* Surveying for staking of the structure locations.

* Foundation installation (if required), erecting poles, and installing wire.

* When the Point of Interconnection is a manually operated, air-break disconnect switch located on the generator’s/customer’s property immediately adjacent to existing EED transmission facilities, the installation and adjustment of the air-break switch and its supporting structure.

* For a transmission line(s) to an EED-owned substation, installing dead-end assemblies on the substation terminal structures, stringing wires to the terminal structures, and leaving conductor “pig-tails” of sufficient length to complete the connections at the substation.

When underground transmission facilities are required, EED is responsible for the following items on its own line(s):

* Procuring manholes, conduit, cable, and related accessories.

* Surveying for staking of the conduit and manholes.

* Installing conduit, manholes, cables, accessories, and other ancillary equipment.

* The underground transmission terminations on EED cable(s) at the Point(s) of Interconnection, or at the terminal structure(s) in the case of an EED-owned substation.

**Generator’s/Customer’s Scope**

For the generator’s/customer’s transmission line or lines, the generator/customer is responsible for:

* Acquiring all property for transmission line rights-of-way, including environmental and jurisdictional permitting. This includes all necessary zoning and/or special use permits to the Point(s) of Interconnection.

* Property survey, including coordinating with EED’s surveyors.

* Necessary and appropriate environmental assessments and field work, including delineating wetlands.
* Attaching the generator’s/customer’s conductors to the structure at the Point of Interconnection plus installing and completing his jumpers at the Point of Interconnection. This includes pressing lugs to connect the conductors to terminal pads on EED’s equipment. The customer needs to furnish the jumper insulators and the terminal lugs. EED terminations will typically accommodate standard NEMA 4-hole bolted lugs (i.e., flat pad with four holes drilled in a square 1-3/4” x 1-3/4” pattern).

* NOTE: If EED upgrades its transmission facilities due to the requirements of the generator/customer, the generator/customer is responsible for upgrading his own, interconnected facilities in a comparable manner, as required.