PPL ELECTRIC UTILITIES`
RELAY AND CONTROL REQUIREMENTS FOR INTERCONNECTION OF TRANSMISSION VOLTAGE CUSTOMER-OWNED FACILITIES (500 KV & 230 KV)

Contributing Parties:

	Signature	Department	Date
	Primary Group		
Preparer:	Ken Schuette	Relay Engineering	4/3/2019
Reviewer:	Enrique Rodriguez-Arce	Relay Engineering	4/3/2019
Approver:	Michael Wolf	Relay Engineering	4/3/2019
	Interfacing Groups		
Group 1:	Valerie A. Saveri	BES Interconnection Affairs	4/3/2019
Group 2:	Jane F. Miller	Key Account Manager	4/3/2019
Group 3:			

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FOREWORD

The information contained in this document was prepared by PPL Electric Utilities (PPL EU). This information represents minimum design requirements relative to safe and reliable operation for the PPL EU system and personnel. However, this shall not relieve the customer from sole and complete responsibility for all aspects of design, installation, and operation of his facilities. Neither PPL EU nor any person acting on behalf of PPL EU;

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To ensure that all proposed installations are handled uniformly and to minimize the possibility of misinterpreting PPL EU requirements, this document outlines the protection and control requirements for operation of customer-owned interconnections in parallel with PPL EU's 230 kV and 500 kV systems. These requirements are designed to ensure the safety of the general public and PPL EU personnel and minimize possible damage to PPL EU equipment and that of other PPL EU customers.

These protection packages, designated as POC, or Point of Contact, and IPR, or Intertie Protective Relaying, are not intended or specified to provide protection for the customer's interconnection equipment or facilities. The customer must provide additional protection devices to adequately protect customer equipment; any protection of the customer's generation equipment or other facilities that is provided by the POC and IPR protection packages is coincidental—it must not be relied upon, even partially, for comprehensive protection of the customer's equipment. Accordingly, the current transformers, potential transformers, main protective relays, auxiliary relays, and tripping contacts used in the POC and IPR circuits are reserved exclusively for protection of the PPL EU system; totally separate facilities must be provided for the customer's interconnection and other equipment protection. No additional relaying, metering or monitoring devices may be included in the current transformer (CT) circuits or potential transformer (PT) circuits designated for POC and IPR protection. Similarly, the relay settings are specified to provide the best possible protection for the PPL EU system for faults in the customer's equipment; these settings may not coordinate ideally with the customer's low side protective devices or provide complete protection of the customer's equipment.

SCOPE

This document is intended for customer installations interconnected to the PPL EU transmission (500 kV and 230 kV) systems. These intended customer installations will be interconnected to the PPL EU system via a separate switchyard (designated as an Intermediate Switchyard) with specific switchyard configuration requirements, as discussed in this document.

The installation of the customer interconnected equipment shall not cause any reduction in the quality of service to other PPL EU customers.

Generation connected to networked facilities above 100kV (on the PPL EU system, this will be at 138 kV and above), must meet established PPL EU standards and the reliability requirements and standards of the RFC (Reliability First Corporation), NERC (North American Electric Reliability Council), FERC (Federal Energy Regulatory Commission) and PJM Interconnection entities. These standards are publicly available and can be obtained by contacting the corresponding organization. Facilities must also comply with city, state and federal environmental and safety laws and regulations.

The standards and requirements developed by PPL EU (that the interconnection customer must adhere to) are accessible through the following link: PPL EU Technical Standards on PJM Website

As a member of PJM, all proposed interconnections to the PPL EU 500 kV or 230 kV transmission systems must follow the processes outlined in PJM Manual M-14A, New Services Request Process, and Manual M-14G, Generation Interconnection Requests. These manuals should be consulted as the first steps to initiate a request to connect customer's facilities to the PPL EU 500 kV or 230 kV systems. Any customer connecting to the PPL EU system under the PJM Interconnection process must be aware of and meet the requirements specified in the applicable PJM series of manuals, found on the PJM Interconnection website at: PJM Interconnection Library of Manuals.

If there are any questions for PPL EU regarding the process initiation, please contact PPL EU at PPLT-PlanningCustomerRequest@pplweb.com.

Note that abbreviations and acronyms as used throughout this document are defined in the table titled "**DEFINITIONS OF ACRONYMS AND ABBREVIATIONS**", on sheets 26 and 27.

Table 1 on pages 28 and 29, "**RELAY DEFINITIONS AND FUNCTIONS**", can be referred to for protective relay functions which may be required for POC and IPR protection packages.

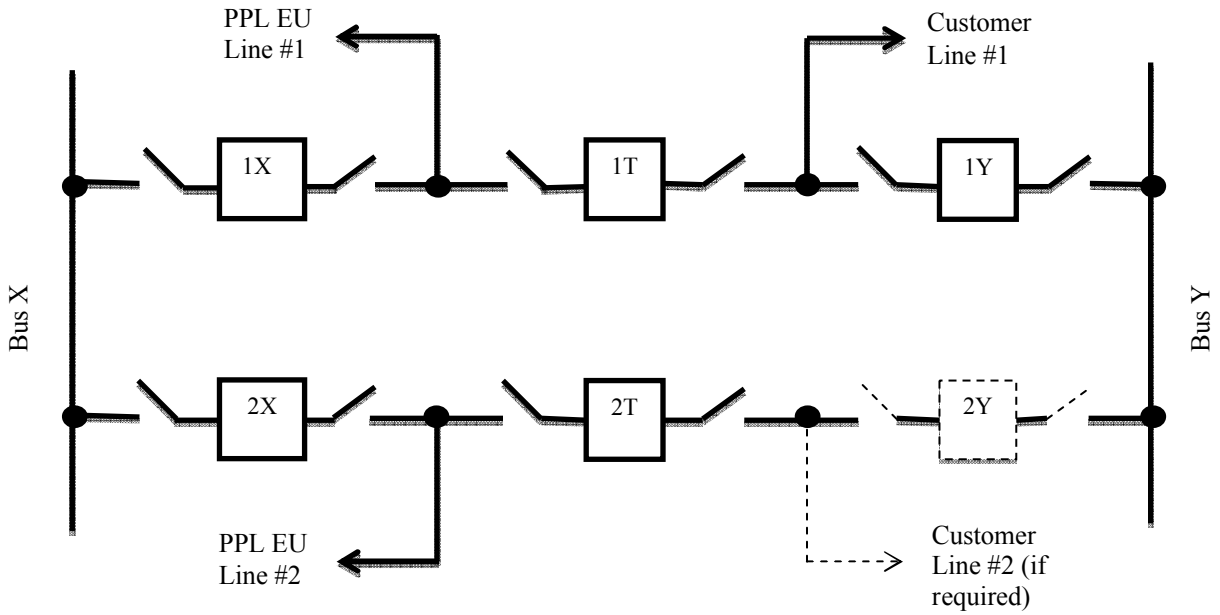
Similarly, standards as used throughout this document are listed in Appendix 1, "Applicable ANSI, IEEE, NEMA, NFPA & UL Standards".

SECTION 1 INTERMEDIATE SWITCHYARD AND CONNECTING LINE(S) REQUIREMENTS

All new customer interconnections on the networked PPL EU 230 kV and 500 kV systems will be required to connect into a dedicated switchyard bay. If the requested Point of Interconnection is in the middle of a networked 230 kV or 500 kV line, PPL EU requires the installation of an intermediate switchyard of the appropriate voltage. The PPL EU line will not be tapped; rather the designated PPL EU networked supply line will be terminated as two separate line terminals in the new intermediate switchyard (in effect, the existing line will be split into two lines). These intermediate switchyards are the responsibility of the customer to provide, but at the end of the construction project, PPL EU will own and operate the intermediate switchyards. The configuration of the intermediate switchyards will be as follows:

- Two buses, each with three single-phase station service voltage transformers and three single-phase instrument voltage transformers for protection purposes.
- One breaker-and-a-half bay, complete with three breakers (Bay 1, below). One PPL EU line will be terminated between two adjacent breakers and the line to the customer's interconnection will be terminated between the other two adjacent breakers. Each line position will be provided with a set of three single-phase instrument voltage transformers.
- One double-breaker, double-bus bay, complete with two breakers (Bay 2, below). The connection to the other PPL EU line will be terminated between the adjacent breakers of that bay. (If the customer requests two supply line interconnections, then this bay will be constructed as a breaker-and-a-half bay, with terminations similar to Bay 1). Each line position will be provided with a set of three single-phase instrument voltage transformers.

A sample one-line diagram for this switchyard is as follows:



Intermediate Switchyard for Customer Connection

In this diagram, note that the PPL EU line which is being tapped to connect to the customer's facilities will be split to form two lines with two new terminals, each located in separate bays. If only one supply line to the new customer's facilities is required, then one breaker-and-a-half bay and one double-breaker, double-bus bay configuration is required, but if two supply lines are needed, then a second breaker-and-a-half bay configuration (including breaker position 2Y and accompanying disconnect switches, as shown in dashed lines) is required.

OPTION TO BUILD

Normally, PPL EU prefers to design and construct the intermediate switchyard and connecting lines; however, the costs incurred to design and construct the facilities are the responsibility of the customer.

However, if the interconnection customer elects to construct the PPL EU interconnection facilities under the Option to Build, the facilities must be constructed to PPL EU standards, using PPL EU approved equipment and PPL EU approved contractors. Details regarding this option for the customer to provide the intermediate switchyard and/or the high voltage connection line can be found in documents which are available on the PJM website as follows: PPL EU Technical Standards on PJM Website

Protection Requirements

The protective relay and control schemes to be used in developing the intermediate switchyard and connecting line(s) must be per the **protection requirements** discussed in the PPL EU Engineering Instruction 02-085, "PPL EU Requirements for Transmission Connected Facilities To Be Owned and Operated by PPL EU: Attachment 3". This document is available from the PJM website, PPL EU Technical Standards on PJM Website. This document presents the philosophy, practices and specific requirements for customers who wish to connect to the PPL EU system at the 500 kV and 230 kV levels (as well as the 138 kV and 69 kV systems).

If the customer elects to build the intermediate switchyard and/or the connecting supply line to the customer's generating facilities, the protective relays and control equipment for bus protection, line protection, breaker controls, metering and data telemetering, must be selected from the PPL EU standard relay list (as presented in the PPL EU specification EU00504398, "Relay and Control Standard Relay List". This document is available from the PJM website, PPL EU Technical Standards on PJM Website.

SECTION 2 CUSTOMER'S FACILITY PROTECTION & CONTROL REQUIREMENTS

PHILOSOPHY

PPL EU has specific protection and control requirements for customers to connect to the utility system at all high voltages. In addition to the transmission line termination requirements (found in Section 1) and the customer's own substation requirements (please review the limitations on the POC and IPR protection functions as discussed in the last paragraph of the **FORWARD** Section), there are two sets of protection requirements required by PPL EU to be installed at the customer's facility:

- The POC (Point of Contact) protection package is required for all customers, with or without generation.
- The IPR (Intertie Protection Relaying) protection package is for customers with generation operating in parallel with PPL EU's system. It is important to note that all customers must have POC protection; the IPR protection package must be added to the POC relay protection package if the customer installs generation.

The POC and IPR protective relay functions MUST be in separate protective relays; primary and backup sets of relays will be provided for both the POC and the IPR protective relay functions.

POC PROTECTION

POC protection is required to protect the PPL EU system (and other customers supplied from the same line) from faults in the customer's equipment. POC protection is not intended or specified to provide protection for the customer's equipment or facilities. The customer must provide additional protection devices to adequately protect customer equipment; any protection of the customer's equipment that is provided by the POC protection is coincidental and must not be relied upon for comprehensive protection of the customer's equipment.

In general, the PPL EU standard POC protection packages (separate primary and backup packages) require separate phase and ground, time and instantaneous overcurrent protection relays (50/51, 50N/51N) per package, to initiate operation of a circuit breaker to isolate the customer's equipment from the PPL EU system in cases when the customer's own protective schemes fail to identify and isolate internal faults.

IPR PROTECTION

Customers who install their own generation to be operated in parallel with the PPL EU system, whether used to simply offset power purchased from PPL EU (no generation is exported), or to sell power via the PPL EU transmission system, are required to install additional separate relays designated as the IPR packages (separate primary and backup packages). The amount of required protection applied to a

particular generator installation will vary with the specific location on PPL EU's system—each "standard" IPR package should contain overvoltage (59), undervoltage (27), over-frequency (81O), under-frequency (81U), directional power or reverse power (32), breaker failure (86BF), directional distance (21), synchronism check (25) relays, timers and other equipment. The actual protection functions employed for a specific customer installation will be determined at the design stage via discussions between PPL EU and the customer.

The primary function of the IPR packages is to isolate the customer's generation from the PPL EU system for faults on the source line; the secondary function is to block closing of all circuit breakers that can be used to connect the customer's generation to the PPL EU system whenever the PPL EU source is unavailable or abnormal.

In addition, the IPR requirements include bidirectional **Direct Transfer Trip (DTT)** — a communication channel between the customer's facilities and the PPL EU intermediate switchyard for breaker failure operations. The DTT allows a trip signal to be sent to the PPL EU remote breaker for failure of a breaker in the customer's facility, as well as a trip signal to the customer's substation allowing the customer's generation to be removed from service quickly for a breaker failure at PPL EU's intermediate switchyard.

The DTT scheme also allows the customer's generation to be quickly removed from service for loss of PPL EU's supply source to the customer. The DTT scheme is considered to be the primary scheme to reliably remove the customer's generation upon loss of the PPL EU supply.

SCADA (Supervisory Control and Data Acquisition) will **not** be required as part of the PPL EU protection package since the PJM requirements include this equipment. PPL EU will obtain the desired data quantities from PJM; this eliminates the need for the customer to provide two separate SCADA RTUs.

PPL EU has a list of acceptable relays for POC and IPR protective relay functions; this list can be found at: **Approved Customer Point of Contact and Generator Intertie Protective Devices.** All relays for POC and/or IPR protective relay functions must be selected from this list.

SPECIFIC PROTECTION SCHEME COMPONENTS

BACKGROUND

The functional characteristics designed into intertie protection schemes for customer-owned generators being connected to the existing PPL EU system are:

- Fast operation by under-voltage protection to disconnect the IPP's facility for a supply line fault or isolation prior to the first instantaneous reclosure. This is required to prevent the generation from possibly sustaining the fault and thus causing the line test from the PPL EU remote terminal to be unsuccessful or to minimize the chance of an out-of-phase reclosure.

- Fast operation on overvoltage protection if overexcitation and/or ferro-resonance cause a rapid, severe voltage rise.

- The interconnection relay systems shall have the capability to withstand electromagnetic interference (EMI) environments (as per IEEE Std. C37.90.2-latest version) so that the influence of EMI shall not result in a change of state or misoperation of the interconnection system.

RELAYS—BASIC PACKAGE

- The intertie protective relays are intended to provide the same functionality as defined in IEEE 1547, the latest version.

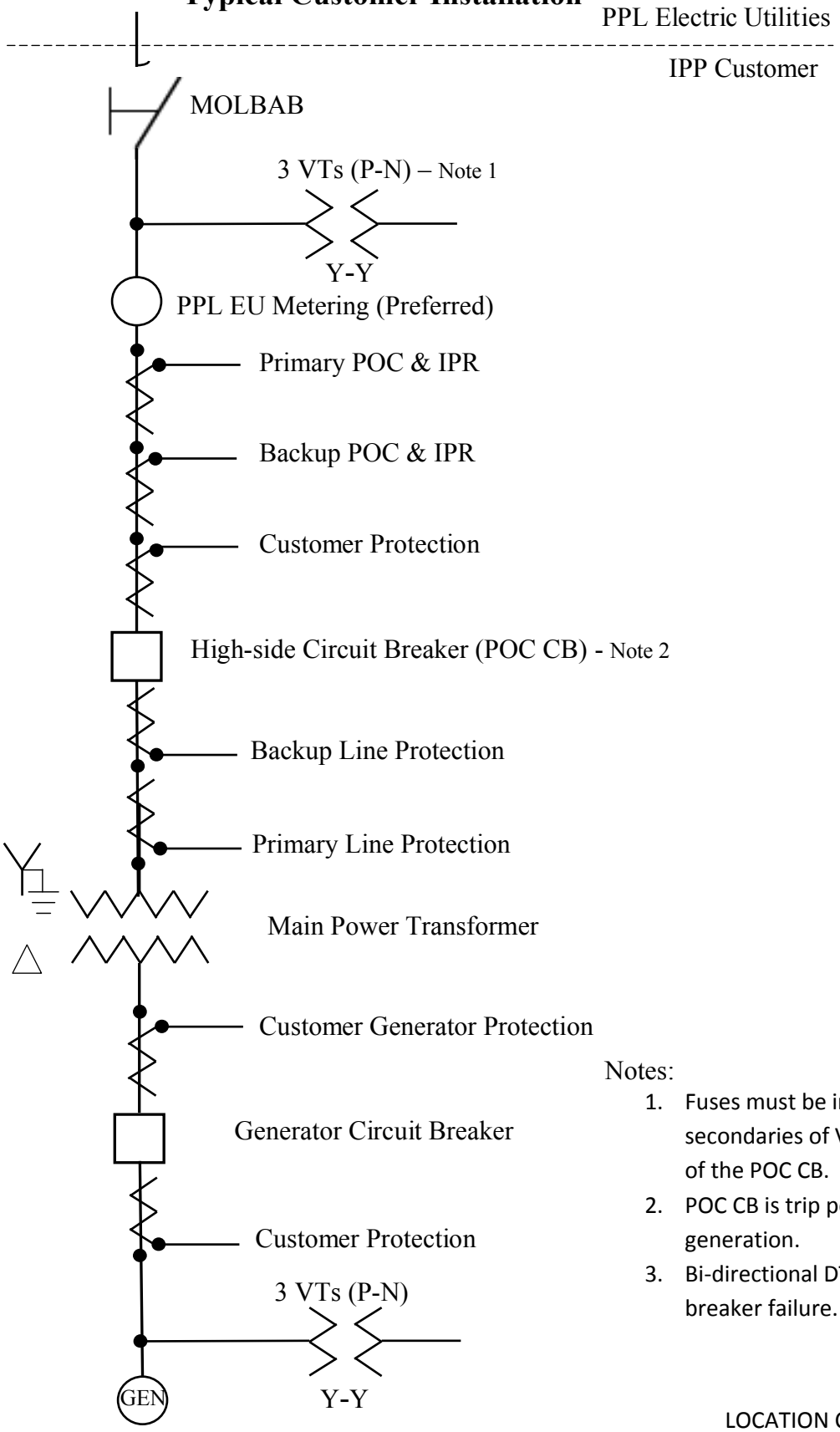
- Large units, while interconnected, can have an appreciable impact on system voltage levels. Also, with more sophisticated controls it is more probable that larger units may continue operating if isolated with a portion of the PPL EU system. There is a need for a precise reactive power or voltage schedule and for a control system which prevents excessive deviation from the developed voltage schedule.

- Obtaining selectivity, to prevent false trips, for system faults not on the PPL EU source line takes on greater importance. Unnecessary tripping of these larger units can have a negative impact on the PPL EU system. **High speed reclosing typically will not be used on these supply lines.**

- Larger units can impact a significant portion of the power system, and therefore, a high assurance is required to clear the generator for trips of the PPL EU supply line to which it is connected.

A typical installation is shown in the following sketch:

Typical Customer Installation



Notes:

1. Fuses must be installed on the secondaries of VTs on PPL EU side of the POC CB.
2. POC CB is trip point to isolate IPP's generation.
3. Bi-directional DTT is required for breaker failure.

LOCATION CODES: R074, R073

GENERAL REQUIREMENTS

With the above background information, **the following items must be provided and discussed early in the design process on all POC/IPR projects** (see also the list of additional items included in **APPENDIX 3**, on page 44)**:**

1. The IPP must provide a one line with sufficient detail to show all transformer connections, and the location and connection of all equipment.

2. The IPP facilities will be required to have primary and backup POC (Point of Contact) protection and primary and backup IPR (Intertie Protection Relay) protection; all schemes trip the POC breaker.

3. The IPP must supply full electrical specifications for all electrical equipment included in the POC and IPR requirements (as well as inverters), including but not limited to the fault current levels and duration.

4. IPP generation facilities connected to the PPL EU 500 kV or 230 kV systems shall have bidirectional DTT (Direct Transfer Trip) installed to the PPL EU source substation; this allows rapid clearing for faults which include a stuck breaker. DTT can also be used to ensure that the IPP's generation is quickly disconnected from the PPL EU system for PPL EU supply line faults and to limit interference with existing PPL EU under-frequency and under-voltage schemes.

5. High voltage CTs and PTs (or CCVTs) will be required for the POC and IPR relaying as well as the revenue metering. In some cases, the PTs (or CCVTs) can be supplied with multiple secondary windings to support both the protection equipment as well as the revenue metering requirements. Separate CTs will be needed for protection and metering. See specific CT and PT (or CCVT) requirements as discussed in the later Section titled, "POC AND IPR CURRENT AND VOLTAGE TRANSFORMERS".

   ATTENTION: PTs or CCVTs located on the PPL EU side of the POC circuit breaker MUST have adequate high voltage fusing to protect PPL EU transmission facilities from equipment failure.

6. PPL EU employs automatic reclosing on its electrical systems. Check the later section titled, "PPL EU RECLOSING" to determine the reclosing schedule.

   NOTE: The above items are specific technical issues. PPL EU will notify the IPP via the Method of Accommodation (MOA) or Method of Supply (MOS) documents of any other requirement(s) which may be necessary after a detailed assessment.

Due to the rapidly changing products for providing various protection requirements, the IPP and PPL EU will discuss current offerings, and come to an agreement on suitable protection packages. Generation equipment certified to IEEE 1547 will include sufficient protection for most installations. Occasionally the generation will have such a large impact that the PPL EU equipment cannot be coordinated with the generation facility, or the generation facility can support operation as an island. Under these circumstances, additional protection beyond that specified in IEEE 1547 may be required.

MICROPROCESSOR-BASED RELAYS, PROGRAMMABLE LOGIC CONTROLLERS (PLCs), TRIPPING SOURCES AND REMOTE ALARMS

If the customer chooses multifunction microprocessor-based relays and programmable logic controllers to provide the POC and IPR protection and control of the substation, the following requirements must be met:

Multifunction Microprocessor-based Relays

Power sources that supply microprocessor-based relays must be uninterruptible. (Relays which are powered from the current transformers and do not require separate power supplies are preferable.)

With the trend to using microprocessor-based relays, and the tendency to include all the required POC or IPR protection in (separate) single devices, the impact of failure of one device must be considered. PPL EU requires that two (2) independent relays (or packages) be provided for each protection scheme (i.e. two relays for the POC protection and two relays for the IPR protection), such that failure of one relay will allow continued operation of the customer's facility until the failed relay can be repaired or replaced.

For all installations, the preferred relays are microprocessor-based units with multiple functions. These relays provide many of the above functions in one device case as well as sequence of events capability. All microprocessor-based relays are to be ordered with suitable ports and communication software to allow setting and transferring of data from a laptop computer.

Control logic included in microprocessor POC and IPR relays shall **not** be used to provide control functions of the POC breaker.

Programmable Logic Controllers

When customers choose Programmable Logic Controllers (PLCs) for control, all POC breaker tripping must be accomplished via hard-wired control circuits and must operate independently of the PLC controls. This is required for trip functions from:

- IPR relays and POC relays (including differential and/or summation over-current relay schemes, if considered to be part of the POC protection package)
- Control switches—trip and closing functions
- Automatic source transfer schemes (such as are permitted at customer substations with two supply sources, including customer-owned generation)

PLC control schemes are permissible for automatic operations such as source transfers of the POC breakers, but the PLC controls must be "backed up" or duplicated by hard-wired interlocks provided to prevent paralleling the utility supply lines.

Tripping Sources and Remote Alarms

- POC breaker trip controls must be via DC supply.

- Provisions must be made to remotely monitor DC power sources, microprocessor-based relays, and PLC failures. In general, all device alarms (such as loss of AC potential, relay failure, loss of control power, battery charger alarms, etc.) should be connected to a central annunciator or monitoring panel. All alarms (whether indicating lights, annunciators, or horns/strobe lights), must be routed to a **manned location** where the alarm condition will be noticed and analyzed in a timely manner. **PPL EU must be notified of these alarms, and corrective actions planned, as soon as possible.**

TRIPPING RELAYS

The current microprocessor-based protective relays typically provide multiple tripping and block closing contacts. These contacts shall be connected to directly trip and directly block closing of the required breaker.

When a normally de-energized auxiliary relay or lockout is used to trip and block closing of the generator or other breaker, the IPP must install suitable equipment to monitor continuity of this relay coil, without affecting operation. This additional equipment must be mounted in the POC and IPR cabinet.

NOTE: Under no circumstances are the POC and/or IPR relays to trip through a PLC (programmable logic controller) or other programmable device. The POC and IPR relays must trip directly to avoid any additional time delay for an interposing programmable device. Auxiliary relays can be used only IF ABSOLUTELY necessary. The trip signal may be MONITORED by a PLC or other programmable device to facilitate control functions at the IPP facility.

The interconnection relay system shall have the capability to withstand electromagnetic interference (EMI) environments (as per IEEE Std. C37.90.2-latest version) so that the influence of EMI shall not result in a change of state or misoperation of the interconnection system.

POC AND IPR CURRENT AND VOLTAGE TRANSFORMERS

For all installations, location for the source of relay and revenue metering potentials and currents shall be on the supply side of the POC breaker.

PPL EU will review the voltage transformer (CCVT or PT) and current transformer (CT) ratios for all devices required for the POC and IPR relaying packages. PPL EU requires WYE-connected CCVTs (or PTs) and WYE-connected CTs. These VTs and CTs must be relaying class accuracy and be able to support the connected burden during both normal load and fault conditions. Typically, CCVTs with 200 VA or 400 VA accuracy burden rating and 1000 VA thermal burden rating and class C800, multi-ratio bushing CTs will be acceptable for facilities using discrete relays, but **these values should be discussed for each application**. Equipment with lower ratings must be reviewed by PPL EU.

For generation facilities which are subject to PJM approval, the customer must also ensure that the CTs and PTs used to provide PJM SCADA and metering information meet the PJM requirements as discussed in "PJM Manual 01: Control Center and Data Exchange Requirements".

Upon request, PPL EU will supply fault current data at or near the point of interconnection (POI) to facilitate the proper sizing of protective equipment.

NOTE: CT and VT secondary connections for POC and IPR relaying may be shared; however, these secondary connections are NOT to be shared with any customer or generation relaying, or revenue metering, without prior PPL EU approval. If potential devices with dual or more secondary windings are used, relay and metering functions may share the same potential device if separate secondary windings are assigned to each of the following: customer protection functions, POC and IPR protection functions and revenue metering functions.

ATTENTION: Voltage Transformers at 500kV or 230kV, located on the PPL EU side of the POC circuit breaker MUST have adequate primary (high voltage) fusing to protect PPL EU transmission/distribution facilities from equipment failure.

METERING AND INDICATION, SYNCHRONISM CHECK, ETC.

All installations must include:

- An ammeter and an ammeter switch to monitor all three phases or a suitable 3-phase digital display.
- A visible SEMAPHORE on each of the breakers between the generator and the PPL EU system to determine the actual status of the breaker (open or close).

To prevent a possible undesirable (out-of-phase) connection of the generation to the PPL EU system, synchronous generators will require a synchronism check relay (25). Induction generators require a voltage check relay (27). These devices must be mounted in the POC and IPR cabinet and connected to prevent closing of the generator circuit breaker, or other breaker as agreed to by PPL EU, for:

- An out-of-phase condition.
- A de-energized line condition (PPL EU supply breaker open).
- A de-energized synchronous generator condition.
- An energized induction generator condition.

When a synchronism or voltage check relay is required, the IPP must install a relay accuracy class voltage transformer on the generator side of the generator breaker, or other breaker as agreed to by PPL EU, to supply potential to this relay.

CONTROL SWITCHES

The IPP must provide a PPL EU CONTROL SWITCH (designated PCS), located in the POC and IPR cabinet for PPL EU use. This switch will provide the capability to locally disconnect the IPP's generation from the PPL EU system by opening the POC breaker when circumstances require manual disconnection.

See the Appendix 2 for additional switch details.

A standard PPL EU control switch (an example is: General Electric Company Type SB-1, Model 16SB1B2X2) or equivalent (subject to PPL EU approval) with target, sliding contacts, handle and configuration must be used for the PCS (PPL EU control switch). See Attachment LA-94000, Sheet 10, for switch details. Alternative suppliers for this equipment will be considered as long as the functional requirements are met.

The PCS (PPL EU control switch) shall be a three-position switch with spring return from close to normal and from trip to normal. (The "close" position shall be to the right of "Normal" and the "Trip" position shall be to the left of "Normal." This will maintain compatibility with standard PPL EU controls.)

The PCS (PPL EU control switch) shall be wired to **trip but not close** the POC breaker designated for isolation of the customer's generation. The PCS (PPL EU control switch) will provide an interlock to block closing of the designated generator isolation circuit breaker by the IPP's control switch unless the PPL EU control switch is in the "Normal-After-Close" position.

There must be provision for a PPL EU padlock to be installed on the locked cabinet housing this PPL EU control switch to prevent unauthorized access to this switch.

BREAKER STATUS

PPL EU must be able to determine the actual status of the generator (on line or off line) before any switching is attempted on the safety switch or point of contact air switch. Indicating lamps (driven by circuit breaker auxiliary switches) and a means of sensing actual current flow (CTs and an ammeter) or a physical indication of the breaker position (breaker semaphore) must be available to the PPL EU switchman to verify that the IPP's generation is not in parallel operation.

INDICATING LAMPS

Two indicating lights should be located within 6" of the PCS (PPL EU control switch): A red lamp (labeled CLOSED) to indicate when the designated generator isolation circuit breaker is closed, and a green lamp (labeled OPEN) to indicate when the designated generator isolation circuit breaker is open.

CONTROL SYSTEMS

The control system must be a DC system; it will use a battery to supply tripping energy to the generator circuit breaker. This DC source must be continuously monitored by the (27/DC) undervoltage relay which will trip the generator circuit breaker if the DC source voltage falls below 10% of nominal. In general, the DC system should use normally de-energized relays.

All such installations must isolate (trip) the generator in such a manner that uncontrolled automatic reclosing of the generator breaker cannot occur for:

- A manual tripping operation, or
- An automatic (protective-relay initiated) operation. In such situations, a time-delayed automatic synchro-check or voltage-check supervised operation is required to close the generator breaker (contactor) after the PPL EU source has returned to normal.

Under no circumstances is the generator contactor (breaker) to close immediately upon restoration of the PPL EU source. An automatic reclosing operation of these facilities must be discussed with PPL EU prior to implementation.

An amber or yellow lamp with a nameplate should be provided to monitor the DC source.

PPL EU RECLOSING

The requirement for synchronism-check or voltage supervised reclosing of the generation isolation breaker provides protection of the PPL EU system and the equipment of PPL EU customers. Unsupervised reclosing with parallel generation could cause damage to the customer's equipment. It is the customer's responsibility to evaluate the potential effect of PPL EU reclosing practices on the generation system and to provide suitable protection.

PPL EU lines operated at 500 kV and 230 kV utilize the following reclosing schedule:

- 500 kV Lines – One shot reclose at 45 cycles (0.75 seconds)
- 230 kV Lines – Two shots reclose at 90 cycles (1.5 seconds) and 900 cycles (15 seconds)

Reclosing logic for these lines must include synchronism check relaying and/or direct transfer trip (DTT) signaling facilities to minimize the possibility of closing out-of-phase into an isolated generator.

TARGETS

POC and IPR relays must be equipped with targets that indicate operation of the relay. These targets are to be arranged in the control circuit to operate only when the associated relays trip the designated generator isolation breaker (which could consist of the point-of-contact circuit breaker). Microprocessor-based relays will have internal targets (typically LED indicators) to indicate the type of fault and trip status.

CURRENT AND POTENTIAL CIRCUIT GROUNDING

Neutral circuits must not be confused with the station ground. All current and potential neutrals are to be isolated from all other circuits and grounded at one point only. The preferred grounding location will be at the POC and IPR cabinet, on the cable side of the isolating links.

BREAKER FAILURE PROTECTION AND DIRECT TRANSFER TRIP

Breaker failure protection must be provided on the 500 kV or 230 kV breakers installed in the customer's facility, as well as the generator breaker and any other breakers in between. Failure of any breaker must initiate the breaker failure scheme to clear the generation from the PPL EU system.

The objective of the breaker failure scheme is to isolate the customer's generation from the PPL EU system for either of the two conditions:

- Failure to clear the customer's generation for faults detected in the customer's equipment, or
- Failure to clear the customer's generation from the PPL EU system upon receipt of a DTT signal from the remote PPL EU supply substation.

Breaker failure protection will consist of both local breaker failure protection schemes (designed to isolate the customer's generation from the PPL EU system when needed) and breaker failure schemes using a DTT signal to be initiated to remotely trip the PPL EU substation breaker supplying the IPP's facilities.

Design and operation of the breaker failure scheme must be discussed between the IPP and PPL EU.

GENERATOR ISOLATION BREAKER

This breaker is typically the main device used to isolate the generation from the PPL EU system; usually this breaker is the POC breaker (but could be a breaker closer to the generator—this selection is to be discussed early in the design phase). It must be able to withstand 2 per unit voltage (minimum) across the open contacts. It should be equipped with breaker failure protection to provide an alternate means of isolation of the customer's generation should the breaker fail to trip. It may be necessary to coordinate the breaker failure relaying with PPL EU protective relaying. SF-6 insulated breakers require special consideration since loss of SF-6 gas pressure will reduce the breaker's dielectric capability and the ability to interrupt current. Consequently, loss of SF-6 gas must initiate both a local alarm and a SCADA alarm, and then trip the breaker before the gas pressure is too low to operate the breaker. (The manufacturer's recommendation for the specific breaker will be carefully reviewed to determine if the suggested operation on loss of SF-6 gas will be acceptable on the PPL EU system.)

GENERATOR RELAY SETTINGS

PPL EU will request specific setting information on any generation relays, which will act to trip the generator. The purpose of this request is to review the generation settings to ensure proper coordination of the generation relays with PPL EU operating practices. It is, however, the responsibility of the generator owner to apply generator protective relay settings that will provide adequate generator protection to meet IEEE guidelines and other regulatory body requirements.

PROTECTION AND CONTROL CABINET

PPL EU requires control of the POC and IPR protective relaying packages, including the DTT schemes. This control shall be provided by a dedicated locked cabinet which contains all the POC and IPR relays, auxiliary relays, and DTT equipment with a PPL EU lock on the cabinet door (additionally, passwords may be applied on the relays). The POC and IPR relay packages are provided strictly for protection of PPL EU's system from issues in the customer's facilities; NO customer's generation or other equipment protection or control logic is to be implemented in the POC and/or IPR relay packages. PPL EU will specify relaying requirements and any special metering for the generation installation.

PPL EU personnel must have access to the locked POC and IPR cabinet. A procedure must be in place for PPL EU personnel to contact the customer to arrange for access in a timely manner.

This POC and IPR cabinet is to be located inside of a suitable building to protect the sensitive electronic equipment from the weather and to provide shelter during maintenance activities. Locating this equipment in a cabinet outside, for example, is **not acceptable**. Locating this in a metal enclosed switchgear facility would be acceptable, but thermostats and heaters must be provided.

IEEE 1547 compliant equipment for the IPP's generator protection will typically be housed or otherwise included in the generation facility, not in the POC and IPR cabinet. For this reason, the specifications included in this PPL EU document will not apply to the customer's generation protection equipment. If protection, control, or monitoring equipment is required in addition to the IEEE 1547 compliant equipment, then these PPL EU requirements should be followed as closely as possible for the proposed installation. Special purpose schemes may be required depending on the impact of the facility.

CABINET GENERAL DESIGN

- Only POC and IPR relays as detailed by PPL EU may be installed in the POC and IPR cabinet. These relays will NOT contain any customer or generation logic, interlocks, alarms, or controls.
- The customer will furnish all equipment required for the POC and IPR cabinet, except for special metering equipment, if required.
- All component (relay, resistor, fuse, etc.) ratings and ranges for the POC and IPR packages must be reviewed by PPL EU.
- The customer is requested to identify PPL EU as the end user to all suppliers of protective relays and switches. In general, PPL EU will control the equipment; PPL EU requests vendor notification for possible firmware updates or manufacturers service bulletins.
- The maximum voltages allowed in the cabinet are 140 VDC and 240 VAC nominal. Any voltages above this level must be barricaded and labeled.
- All relays must be current production utility grade relays and must be reviewed by PPL EU. PPL EU will supply a list of currently approved vendors; see **Approved Customer Point of Contact**

and Generator Intertie Protective Devices.

- PPL EU will inspect the cabinet prior to assuming operational control; any deficiencies must be corrected by the customer before acceptance

- The customer is responsible for mounting the cabinet in an easily accessible location. The customer shall provide an access procedure to PPL EU for accessing all equipment under the responsibility of PPL EU.

- The customer shall supply copies of the drawings listed below for review by PPL EU. Contact PPL EU for the specific quantity required, if paper copies are to be supplied. AutoCAD is the preferred electronic format; however, PDF is also acceptable. The drawings will be assigned a PPL EU drawing number, entered into the PPL EU drawing system and re-issued as the 'drawings of record' for the customer's installation.

- ALL drawings must be suitable to be scaled to "D" size (22 inches by 34 inches), except for reports, word or excel documents. Reduced size drawings are NOT acceptable.

- PPL EU requires that two (2) POC and two (2) IPR relay packages be provided, so that continued operation of the generation facility will be allowed upon failure of one POC relay or one IPR relay until the failure can be repaired or the relay can be replaced. Failure of a single POC relay or single IPR relay installation requires immediate disconnection of the generation from the PPL EU system.

- PPL EU will assume control of the POC and IPR equipment and will witness all testing performed by customer personnel or contractors.

EQUIPMENT CABINET DETAILS

For indoor installations all walkways around the POC and IPR cabinet must be a minimum of three (3) feet wide. Any other structures or cabinets must not obstruct full opening of the doors.

Following are the guidelines for the IPR equipment cabinet:

A. General Construction

The cabinet minimum size must allow easy access to all components and if equipped, must not restrict motion of internal swing panel.

1. POC and IPR cabinets shall conform to specifications for a NEMA Type 4 Enclosure. Specifications for these enclosures are contained in NEMA Standard ICS 6 (latest version).

2. Single-door cabinets will need the following:

   a) A three-point latch handle on the door with provisions for PPL EU's padlock (3/8" hole).

   b) A latch or equivalent to keep the door in the 100 degree and 120 degree open positions and

hold it there if so desired. A permanent stop should be provided so that the door will not be opened beyond the 120 degree open position.

c) The cabinet shall have a fixed rear panel suitable for device mounting.

d) An all-around door gasket of neoprene or equivalent for outdoor cabinets.

e) A continuously-hinged equipment panel, opening in the same direction as the door.

f) A handle to facilitate opening and closing of the hinged equipment panel.

g) A latch or equivalent to keep the hinged equipment panel in the open position or the fully closed position and hold it there.

h) All components and wiring must be accessible from the front door.

3. For double-door cabinets all components and wiring must be accessible from the front (and/or rear) doors. If all components are not accessible from the doors, then the cabinet shall have a continuously-hinged panel opening in the same direction as the front access door.

4. The PPL EU PCS control switch is to be mounted in a convenient location to allow for easy access if switching is required. The intended use of this switch is for PPL EU use. The Customer is not to change the position of this switch without contacting PPL EU first.

5. The POC and IPR controls and lamps may be mounted on the door provided that components subjected to an outdoor environment are of weatherproof construction.

6. Space shall be provided near the terminal blocks to allow connection of conduits.

7. Hinges exposed to the weather shall be stainless steel or equivalent non-rusting material.

8. One duplex 120 VAC, 15 amp, receptacle must be located in the cabinet or within 10 feet of the cabinet and must be accessible for PPL EU use. This circuit cannot be supplied by the PT's or VT's used for relaying.

9. Cabinet is to be labeled "Generation name—POC and IPR cabinet" in black letters with a yellow background and a minimum height of 1".

B. Grounding

1. Cabinet and duplex receptacle(s) must be solidly grounded.

WIRING – Guidelines

A. General

1. Cabinet wiring shall meet current NEC and industry standards, and suitable for operation at 90°C.

2. Cabinet wiring should be free from abrasions and tool marks, and all bends of wires shall have a minimum of 1/4" radius.

3. All wires should be anchored to the cabinet or bundled when running between devices. Wiring should be installed so that it can be visually traced and checked.

4. Wiring should be installed to avoid damage to the cable and its insulation. Movement of the hinged panel shall not damage the cable or its insulation or cause stress to the termination points on the panel or on the door.

5. Wires shall be installed such that heat from devices shall not cause cable or wire damage.

6. Wiring and device location should not prevent the removal of any equipment, block access to equipment for inspection and maintenance.

7. All equipment should be mounted and wired in such a manner that no energized terminals or connections are exposed with cabinet swing panels and doors closed.

8. All protective relays or IEDs (Intelligent Electronic Devices) not equipped with internal isolation devices must be connected through an external test device (i.e., WHSE FT-1 or similar as determined and accepted by PPL EU). ALL inputs and outputs for protective relays, IEDs and analog sensing devices are to be connected through suitable test switches. Further, the switches are to be connected to allow the isolation of the device and the injection of current or voltage WITHOUT disturbing other devices that may be connected to the same CTs or PTs.

9. All incoming and outgoing cables/conductors will terminate on sliding link terminal blocks located in the POC and IPR cabinet.

B. Terminal Blocks

1. Terminal blocks shall be mounted such that the connections and links are accessible and not blocked by projecting equipment.

2. Terminal blocks shall be mounted a minimum of 6" from sidewalls and adjacent equipment and a minimum of 4" above the bottom of the housing.

3. Terminal blocks shall be mounted such that the sliding link:

   a. Falls closed when loosened, if mounted in horizontal rows.

   b. Moves toward the front of the cabinet when opened, if mounted in vertical rows on side panels.

   c. Moves away from the panel centerline when opened, if mounted on the rear panel.

4. There shall be a minimum of 10% or 2 (whichever is greater) spare terminals included in the cabinet for modifications.

C. Terminal Connections

1. Wires terminating on a threaded stud such as a relay terminal will be terminated with ring tongue lugs, which completely encircle the screw or the stud. The crimping tool should be suitable for the connectors used.

2. Wires terminating in a screw-clamp will not require any type of lug since the terminal block will accept a bare, properly stripped wire. Sufficient torque should be applied to each screw to secure the wire firmly in the yoke.

3. Soldered terminals or connections should generally be avoided.

D. Wiring Identification

1. A suitable means of identifying the conductors or wiring should be employed to provide a method to trace the wiring.

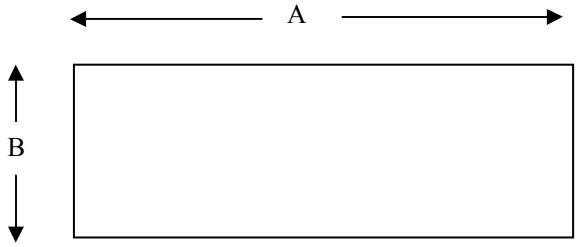
E. Nameplates/Device Identification

1. Suitable nameplates should be applied to the various pieces of equipment to avoid miscommunication or switching errors. The actual text on the nameplates should be shown on the drawings for PPL EU review.

2. The same wording on these nameplates should be referenced in any operational instructions.

Below is a typical list of nameplate schedules.

NAMEPLATE SCHEDULE



NOTE: All dimensions are shown in inches.

DIM A	DIM B	HEIGHT OF LETTERS	WHERE USED
2-1/2	1	7/32	All primary circuits on generating or substation switchboards (up to two lines)
2	¾	1/8	Equipment on switchboards or in cabinets (up to 3 lines)
2-1/4	1-1/2	1/8	Equipment on switch boards or in cabinets (up to 3 lines)
4	1	1/8	Equipment on switch boards or in cabinets (up to 4 lines)
3-5/8	¾	1/8	3 gang fuses and indicating lights (up to 3 lines)
2-3/4	1-1/4	1/8	Equipment on switch boards or in cabinets (up to 5 lines)
1-5/8	13/16	1/8	SCADA
4-1/2	1	7/32	Small cabinet doors (up to 2 lines)
8	2	1/2	Large cabinet doors (up to 2 lines)
3-1/2	1-1/4	7/32	Identification on front and back of switchboards (up to 3 lines)

DRAWINGS

For a complete discussion of drawing requirements and expected drawing content, see **SECTION 5, "DRAWING REQUIREMENTS"**. The types of drawings which PPL EU requires for submittal is detailed, as well as the content of each type of drawing.

In general, PPL EU is interested in the drawings showing the POC and IPR equipment, and the circuit breaker controls for the isolating breaker(s) and generator breakers.

PPL EU will review elementary drawings typically within **15 working days** of receipt. Wiring diagrams or lists will not be reviewed in detail.

Panel construction should not begin until PPL EU has reviewed the elementary drawings.

The customer is responsible for the accuracy of all drawings.

The customer shall supply two copies of all "As Built" drawings, the Description of Operation and instruction books for relay switches, auxiliary relays, VT, CT and any other devices as requested by PPL EU, prior to final acceptance of facility.

DRAWING ACCEPTANCE

All protection and control drawings are subject to review by PPL EU. The elementary drawings (potential, current, and control), the bill of material for the POC and IPR protection packages and the physical layout drawing must be reviewed and ACCEPTED by PPL EU. The customer is expected and required to submit ALL drawings required to completely review the POC and IPR design from the PT and CT inputs, the DC supplies, to the trip and close coils of the controlled equipment as well as all interlock devices. This

includes any manufacturers or subcontractor drawings. NOTE: all drawings submitted electronically, must be scalable to the original size for plotting. See "Drawing Requirements for Generation Intertie Protective Relay Cabinets" for further information.

ALL drawings submitted to PPL EU for the generation facility must be signed by a licensed Professional Engineer in good standing in the Commonwealth of Pennsylvania.

All drawings are reviewed subject to this NOTICE:

This information was prepared from a review of customer drawings by PPL Electric Utilities. Drawing review applies only to the general arrangement of the facilities and the primary and the control equipment associated with the POC and IPR protection schemes. Neither PPL EU nor any person acting on behalf of PPL EU (a) assumes any responsibility for the correctness of design, drawings, installation or operation: or (b) assumes any liabilities with respect to the use of, or for damages of any kind resulting from the use of, any comments disclosed in the review document.

Panel construction shall not begin until PPL EU acceptance has been obtained on the above drawings.

METERING OF ELECTRIC SERVICE AND GENERATION

IPP installations may require metering facilities not discussed in PPL EU standards such as REMSI (REMSI will cover the metering requirements for IPP facilities connecting to PPL EU's 12 kV system). To obtain these requirements, contact PPL Electric Utilities Business Accounts Department at telephone number **1-888-220-9991, menu option 4,** to contact a Business Accounts service representative, who will appropriately respond to your inquiry.

Alternatively, you may initiate a contact to Business Accounts via the PPL EU website at: Business Accounts Department or email them at businessaccounts@pplweb.com.

The subject of metering needs to be discussed in detail to ensure that the correct sensing equipment is installed for the desired operation. There are many variations on the sale and purchase of the power associated with these types of facilities. A complete discussion of all these options is outside the scope of this document; contact PPL Electric Utilities for the various options.

In general, all CTs, PTs and meters for Billing Metering will be specified by PPL EU along with necessary information about metering requirements. No relays or other meters are to be connected to the CTs and PTs used for Billing Metering. Similarly, no customer substation loads will be connected to billing metering CTs or PTs.

IPPs that intend to participate in the PJM market will need to make arrangements to get specific information to PJM in a timely manner. One method to accomplish this is the installation of a PJM SCADA RTU. This PJM SCADA RTU uses the Internet to transmit data to PJM and can also connect to revenue meters to get the required information. This option must be discussed if PPL EU supplies the metering equipment.

DEFINITIONS OF ACRONYMS AND ABBREVIATIONS

The following defined acronyms and abbreviations are used for various utility and customer facilities' configurations:

AMS	Alarm Management System
AC	Alternating Current
ANSI	American National Standards Institute
CB	Circuit Breaker
CT	Current Transformer
CCVT	Coupling Capacitor Voltage Transformer
DC	Direct Current
DFR	Digital Fault Recorder
DG	Distributed Generation (aka – generator)
DTT	Direct Transfer Trip
FERC	Federal Energy Regulatory Commission
GPS	Global Positioning System
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input/Output
IPP	Independent Power Producers (aka – generation provider)
IPR	Intertie Protective Relay (can refer to a relay or a protection package)
KI	Kirk Key Interlock
kV	Kilovolt (1000 volts)
MOLBAB	Motor Operated Load Break Air Break device
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NERC	North American Electric Reliability Corporation
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NUG	Non-Utility Generator (aka – generation provider)
PCC	Point of Common Coupling (synonymous with POC and POI)
PCS	Power Control Switch

PJM	Pennsylvania-New Jersey-Maryland Interconnection
PLC	Programmable Logic Controller
POC	Point of Contact (synonymous with PCC and POI, can refer to relay package)
POI	Point of Interconnection (synonymous with PCC and POC)
PPL EU	PPL Electric Utilities
PUC	Public Utility Commission
PTs	Potential Transformers
REMSI	Rules for Electric Meter and Service Installations
RFC	Reliability First Corporation
RTU	Remote Terminal Unit (for SCADA)
SCADA	Supervisory Control and Data Acquisition
SYNC	Synchronizing
UL	Underwriter's Laboratories
UPS	Uninterruptible Power Supply
VT	Voltage Transformer

TABLE 1

RELAY DEFINITIONS AND FUNCTIONS FOR FIGURES

(Based on ANSI/IEEE Standard Device Numbers)

TYPE	FUNCTION	DESCRIPTION
21Z1	Zone 1 Distance	Provides a trip signal for a power system fault on the PPL EU supply line.
21Z0S	Out-of-Step	Provides a trip signal for loss of power system-generator synchronism.
25	Synchronism Check	Provides a 'permission to close signal' to the breaker used to parallel the generation to the PPL EU system.
27GEN	Generator Voltage Check	Used to block closing of generator breaker (or other) if voltage is present on generator side. Used primarily with induction generators.
27I	Instantaneous Undervoltage	Provides a trip signal within three cycles of an undervoltage condition; also provides a block closing signal until source is normal.
27N	Narrow Band High Accuracy Undervoltage	Set above 27I or 27T; provides an alarm to generator operator and a trip after a delay (via 62L) of several minutes. (99% reset)
27T	Time Delay Undervoltage	Set at 94% of nominal voltage with a time delay of 0.1 to 2.0 seconds to override local voltage dips.
27DC	Battery Monitor	Set to trip the generator breaker when the battery reaches ≅90% of nominal DC voltage with a time delay sufficient to override momentary voltage transients.
32	Power Directional	Monitors power flow into PPL EU system.
51V	Torque-Controlled Time Overcurrent	Set to approximately 25% of the machine full load rating with the torque control being supplied by the 27 relay(s).
50/51	Time and Instantaneous Overcurrent	This is the POC protection and is connected to monitor phase current flow on the high side of the transformer.
50/51N	Time and Instantaneous Overcurrent Neutral	This relay is connected to monitor the neutral current flow in the high side of WYE connected transformers. It is usually set to 1 amp secondary current.
59I	Instantaneous Overvoltage	Set at 120% of nominal voltage

59N	Narrow Band High Accuracy Overvoltage	Set below 59I/59T; provides an alarm to generator operator and a trip after a delay (via Overvoltage 62L) of several minutes.
59T	Time Delay Overvoltage	Set at 106% of nominal voltage with a time Overvoltage delay of 0.1 to 2.0 seconds
62	Auxiliary Timer (Short Time)	Used with 27I and/or 59I to produce 27T and/or 59T function.
62L	Auxiliary Timer (Long Time)	Used with 27N and 59N to provide several minutes of delay to allow plant operator to correct voltage deviation.
810	Overfrequency	Typically set at 60.5 Hz.
81U	Underfrequency	Typically set at 59.5 Hz with no time delay. May be set to 57.5 Hz with 5.0-second delay for large units to coordinate with load shedding relays.
DTT1	Direct Transfer Trip	Sends a signal from PPL EU Terminal A to trip a customer's generator.
DTT2	Direct Transfer Trip	Same as DTT1 except to Terminal B.

NOTE: For all installations, the preferred relays are microprocessor-based units which usually include multiple protection and/or control functions. These relays provide many of the above functions in one case as well as oscillographic and sequence of events capability. ALL microprocessor-based relays are to be supplied with suitable communication software to allow transfer of data and settings from a personal computer and are required to derive control power from a DC source. AC supply of microprocessor-based relays from the grid is not acceptable.

SECTION 3 RESPONSIBILITIES

METERING AND POC/IPR RELAYING RESPONSIBILITIES

The matrix below indicates responsibilities relating to metering equipment and POC/IPR/DTT relaying:

RESPONSIBILITY	METERING (230kV or 500kV)	POC/IPR/DTT RELAYING
Purchasing	PPL EU [3] (Preferred)	IPP/Customer
Specifying	PPL EU [3]	IPP/Customer [1]
Installing	PPL EU [3,5] (Preferred)	IPP/Customer
Commissioning	PPL EU [3,5] (Preferred)	IPP/Customer [2]
Owning	PPL EU [3,5,6] (Preferred)	IPP/Customer
Maintaining	PPL EU [3,5,6,7,8] (Preferred)	IPP/Customer [7,8]
Controlling	PPL EU [3,5,6]	PPL EU [9]

[1] The Customer shall select POC and IPR relaying from a list of PPL EU **Approved Customer Point of Contact and Generator Intertie Protective Devices**.

[2] PPL EU shall review the IPP/Customer relay settings to ensure optimal coordination is maintained with the PPL EU system. PPL EU shall witness IPP/Customer testing,

[3] PPL EU prefers to purchase, install, commission, own and maintain the billing meters, but must always specify and control the metering equipment package (including the CTs, PTs and meters). At 500 kV and 230 kV levels, the customer generally purchases, installs, commissions, owns and maintains the CTs and PTs for metering; PJM provides the IPP/Customers the option to assume these responsibilities for the meters also. Again, PPL EU shall always specify and control the metering equipment.

[5] For 230kV and 500kV metering installations,

- If the IPP/Customer decides to purchase, install, commission, own and maintain the metering equipment (mounting, primary connections, conduit, secondary wiring, enclosures, etc.), then the metering equipment shall be installed inside the IPP/Customer substation. The metering equipment shall be installed on the high side of the IPP/Customer transformer(s) before the high side POC breaker(s). PPL EU shall always specify and control the metering equipment.

- If PPL EU purchases, commissions, owns and maintains the metering equipment, it is still preferable that the metering equipment be installed inside the IPP/customer substation. The IPP/customer shall install (mounting, primary connections, conduit, secondary wiring, enclosures, etc.) the metering equipment on the high side of the IPP/Customer transformer(s) before the high side POC breaker(s). PPL EU shall always specify and control the metering equipment.

[6] If PPL EU owns, maintains and controls the metering equipment (CTs, PTs and meter), then the IPP/Customer shall still be responsible for all operating costs associated with these responsibilities performed by PPL EU. Normal costs are bi-annual metering equipment testing, troubleshooting metering equipment and communication (cellular, DNP, KYZ pulses, etc.) issues, and other maintenance.

[7] The IPP/Customer shall contact PPL EU prior to performing any maintenance on the metering or POC/IPR/DTT relaying equipment.

[8] The IPP/Customer may be responsible for any costs associated with PPL EU support for activities initiated by the IPP/Customer.

[9] PPL EU requires all POC and IPR relaying equipment to be installed inside a dedicated cabinet with a latching door suitable for a PPL EU locking device.

COMMUNICATION CHANNEL RESPONSIBILITIES

The matrix below indicates responsibility relating to the DTT communication media type and equipment:

RESPONSIBILITY	TELECO[9]	DIRECT FIBER (230kV or 500kV)	RADIO
Purchasing	IPP/Customer [1,2]	IPP/Customer [2,3]	IPP/Customer [4]
Specifying	PPL EU	PPL EU	IPP/Customer [4]
Installing	IPP/Customer [5]	IPP/Customer [3]	IPP/Customer [5]
Commissioning	IPP/Customer [6]	PPL EU [7]	IPP/Customer [6]
Owning	IPP/Customer	IPP/Customer [8]	IPP/Customer
Maintaining	IPP/Customer [10,11]	IPP/Customer [8,10,11]	IPP/Customer [10,11]
Controlling	IPP/Customer [12]	IPP/Customer [8]	IPP/Customer [12]

[1] The IPP/Customer shall also be responsible for all costs associated with the leasing of the telephone lines

and resolving any problems with the telephone service provider.

[2] The IPP/Customer shall contact PPL EU prior to purchasing any equipment.

[3] The IPP/Customer shall be responsible for the portion required to interconnect with the PPL EU fiber system. PPL EU shall witness all installation performed by the IPP/Customer.

[4] The IPP/Customer shall contact PPL EU prior to purchasing or specifying any equipment.

[5] The IPP/Customer shall also be responsible for installing all communication equipment at the PPL EU facilities. PPL EU shall witness all installation performed by the IPP/Customer.

[6] The IPP/Customer shall perform end-to-end testing, from IPP/Customer communication equipment to PPL EU communication equipment, with support from PPL EU. PPL EU shall witness all testing.

[7] PPL EU shall perform end-to-end testing from the PPL EU substation fiber splice box to the IPP/Customer substation fiber splice box, with support from the IPP/Customer. The IPP/Customer shall witness all testing.

[8] The IPP/Customer shall own, maintain and control all communication equipment up to the PPL EU substation fiber splice box, including the portion along the generator lead line. PPL EU recommends all communication equipment have locking provisions wherever necessary.

[9] If a leased telephone line is to be used for communication, the following items must be considered:

- The customer is responsible to arrange for the leased telephone channel (if available); lead times can be six months or more.
- The cost of the leased telephone installation and monthly charges are the customer's responsibility.
- Teleco providers have strict requirements for physical entrance facilities for their channels; it is the customer's responsibility to determine these requirements.
- The customer must discuss with PPL EU in advance to determine the acceptable circuit parameters for the leased telephone channels.

[10] The IPP/Customer shall contact PPL EU prior to performing any maintenance on the communication equipment.

[11] The IPP/Customer may be responsible for any costs associated with PPL EU support for maintenance activities initiated by the IPP/Customer.

[12] The IPP/Customer shall also control all communication equipment at the PPL EU facilities. PPL EU recommends all communication equipment have locking provisions wherever necessary.

SECTION 4 RELAY TEST PROCEDURES

The Relay Test Department at PPL EU provides technical field support for all customer Point of Contact (POC) installations and Intertie Protective Relay (IPR) installations involving systems with protection relays. They should be included in the early review of customer POC and IPR systems, along with other key PPL EU groups, to help the IPP to develop an optimum and effective design.

As the POC and IPR work progresses to the physical construction stage, Relay Test will participate in an initial "on-site" job meeting to develop a work plan to support all issues of concern to Test which are required to connect the customer to the PPL EU system.

These include POC and IPR related protection equipment:

1. Relay acceptance tests and calibration of settings (issued by PPL EU Protection and Control Engineering)
2. Current Transformer tests
3. Current Transformer saturation tests
4. Current circuit verification
5. Potential circuit verification
6. Control circuit tests
7. In-service verification tests
8. Secure the relays form tampering by use of a PPL EU padlock to the handle of the IPR cabinet, plus possibly also applying software passwords or by applying a PPL EU seal, as applicable to the relay type.
9. Plus, any other issues related to the POC and IPR systems

PPL EU Relay Test personnel will complete items 1, 7 and 8. Items 2 through 6 can be done by the customer's contractor and witnessed by Relay Test employees or completed by Relay Test with customer participation as appropriate.

PPL EU Relay Test personnel will require a written commissioning procedure proposed by the IPP's contractor. This procedure should cover a step-by-step listing of the tests required to ensure that the IPP's POC and IPR schemes operate properly. This commissioning procedure should be supplied to PPL EU at least two weeks prior to the scheduled in-service testing process. The IPP is to provide a detailed procedure for PPL EU review of the initial phase-out and synchronization. This must be reviewed prior to actual synchronization (generally only larger systems).

One of the responsibilities of the PPL EU Relay Test personnel is to secure the POC and IPR relays upon successful completion of the commissioning procedure. The POC and IPR cabinet required to house the

IPR relay packages will be supplied with a cabinet door suitable for securing with a suitable lock. In addition, the POC and IPR relays can be secured via use of passwords to limit access. The POC and IPR protection equipment is installed to protect the PPL EU system from adverse effects of the customer's equipment. For this reason, control of this equipment must remain with PPL EU.

Customers are billed for work done by PPL EU personnel outside of the "core working hours" (for example, if the customer wants commissioning activities completed during evening or weekend hours). The customer should be aware of this policy.

PPL EU will observe verification of the correct operation of the generator isolation breaker synchronizing circuit.

The IPP is to verify the phase rotation of the generator. Please note that the PPL EU 230 kV system rotation is C-B-A; the 500 kV system rotation is A-B-C (the phase change is accomplished at the terminals of the 500-230 kV transformers). The generator is expected to verify with PPL EU the specific rotation at their facility.

SECTION 5 DRAWING REQUIREMENTS

ALL drawings must be suitable to be scaled to "D" size (24 inches by 36 inches), except for reports, word or excel documents. Reduced size drawings are NOT acceptable.

DRAWINGS AND INFORMATION FOR REVIEW

PPL EU's Protection and Control Engineering section will require the following drawings/information for review and acceptance:

- One Line Diagram *
- Three Line Diagram
- Transmission Line Dead-End Structure (proposed/final)
- Plan and Elevation Views (electrical arrangements only)
- Grounding Plan and Details
- Ground Test Report (customer substation is complete but before PPL EU supplies are connected) *
- Bill of Material (major electrical equipment only, including switch, protective device, transformer, surge arresters, relays, etc.) *
- Switch Interlock Schematic and Details
- Three Line Potential Elementary
- Three Line Current Elementary *
- Control Elementaries
- Power Transformer Certified Test Report(s)
- Front view showing POC Relay and Control Equipment *
- A detailed written description of Point of Contact (POC) and Intertie Protective Relay (IPR) protection and control functions and description of operation to include the following: *
    - Point of contact breaker or low side circuit breaker
    - Generator circuit breaker
    - Controls associated with the above circuit breakers
    - Any other equipment that connects to the above breakers
    - System interlocks
    - Direct transfer Trip equipment
    - General description of the operation of the facility, including operational modes [parallel, isolated, peak shaving, etc.)
    - Any other unique facilities or operational modes
    - High side breaker isolation procedure, if a SF-6 high side breaker is used
    - Commissioning procedure *
    - POC and IPR relay instruction books *
    - POC and IPR CT saturation study *

* Denotes drawings which must be supplied for every type of customer facility. Other drawings must be supplied as applicable.

CONTENTS OF DRAWINGS

The customer's POC and IPR drawings shall contain the following information:

One Line Relay Diagrams

This drawing shows the customer's substation functional arrangement. All the equipment shall be shown using single-line diagram and standard symbol notations (per latest ANSI/IEEE Standard 315; titled Graphic Symbols for Electrical and Electronic Diagrams). This drawing shall include:

- Equipment names and/or numerical designations for main breakers, air switches, power transformers, and associated POC and IPR relays and control devices shall be shown to match with PPL EU line designation. (Note: The required information will be provided by PPL EU after the customer submits a preliminary one line diagram.)
- Power Transformers - Nominal kVA, nominal primary/secondary and tertiary voltages, vector diagram and impedance.
- Instrument Transformers - Voltage and Current that supply the POC relaying.
- Lightning Arresters/Spill Gaps/Surge Capacitors - Ratings.
- Air Switches - Indicate status normally open with a (N.O), normally closed with a (N.C.) and type of operation manual or motor.
- Safety Switch - Continuous ampere and interrupting ratings.
- FIDs - Interrupting rating, continuous rating, operating times.
- Transformer Fuses - Size, type, manufacturer, location.
- Grounding.
- Generator(s) - Include type, connection, kVA, voltage, current, phasing, rotation, PF, etc.
- Point of Connection to PPL EU and phase identification. NOTE: if the generation phase sequence is different than the PPL EU phase sequence, both must be shown on this diagram.

Current Elementary Diagrams

- Terminal designations of all devices - Relay coils and contacts, switches, transducers, etc.

- Relay Functional Designation - Per latest version of ANSI/IEEE standard C-37.2. The same functional designation shall be used on all the drawings showing the relay.
- Complete relay type such as "SEL 321", etc., and the relay range.
- Range and settings of timing relays.
- Switch developments and escutcheons shall be shown on the drawing where the majority of contacts are used. Where contacts of a switch are used on a separate drawing, that drawing should be referenced adjacent to the contacts in the switch development. Any contacts not used should be referenced as spare.
- All switch contacts are to be shown in the open position with each labeled to indicate the positions in which the contacts will be closed.
- Switch contacts shall be referenced to the switch development if development is shown on a separate drawing.
- Isolating points (States sliding links, test switches, etc.).
- Grounding of CT cables.
- All other circuit elements and components with device designation, rating and setting where applicable.
- Current Transformers - Polarity marks, rating, tap, ratio, and connection. Include the rating factors and accuracy classes (i.e. 2000/5 amp, C800/0.3 B1.8)
- Auxiliary CT ratios, connections and polarity, winding current rating, and arrows to indicate assumed current flow.
- Phase designations and rotation of both PPL EU and customer.
- Cable connection number or wire designation.

Potential Elementary Diagrams

- Terminal designations of all devices – relay coils and contacts, switches, transducers. etc.
- Relay functional designation – per latest version of ANSI/IEEE standard C-37.2. The same functional designation shall be used on all the drawings showing the relay.
- Complete relay type such as "SEL 321", etc., and the relay range.
- Relay contacts shall be referenced to the drawing when the coil is shown, provided the coil is shown on a separate drawing.

- Relay contacts should be shown with each referenced to the drawing where they are used. Contacts not used should be referenced as spare.
- Range and settings of timing relays.
- Switch developments and escutcheons shall be shown on the drawing where the majority of contacts are used. Where contacts of a switch are used on a separate drawing, that drawing should be referenced adjacent to the contacts in the switch development. Any contacts not used should be referenced as spare.
- All switch contacts are to be shown in the open position with each labeled to indicate the positions in which the contacts will be closed.
- Switch contacts shall be referenced to the switch development if development is shown on a separate drawing.
- Isolating points (States links, test switches, etc.).
- Grounding of cables.
- All other circuit elements and components with device designation, rating, and setting where applicable.
- Coil voltage for all auxiliary relays.
- Potential transformer – nameplate ratio, polarity marks, rating, primary and secondary connections. Include accuracy class and burden (i.e. 40250/115 0.15 WXMYZ)
- Phase designations and rotation of both the utility and customer.
- Current ratings and designation of all fuses.

Control Elementary Diagrams

Control elementaries are to be functionally complete schematics. They should be as simple and uncluttered as possible, and shall contain the following information:

- Terminal designations of all devices – relay coils and contacts, switches, transducers, etc.
- Relay functional designation – per latest version of ANSI/IEEE standard C-37.2. The same functional designation shall be used on all the drawings showing the relay.
- Complete relay type such as "SEL 321", etc., and the relay range.
- Range and settings of timing relays.

- Switch developments and escutcheons shall be shown on the drawing where most of the contacts are used. Where contacts of a switch are used on a separate drawing, that drawing should be referenced adjacent to the contacts in the switch development. Any contacts not used should be referenced as spare.
- All switch contacts are to be shown in the open position with each labeled to indicate the positions in which the contacts will be closed.
- Switch contacts shall be referenced to the switch development if development is shown on a separate drawing.
- Isolating points (States links, test switches, etc.)
- All other circuit elements and components with device designation, rating, and setting where applicable.
- Cable connection number or wire designation.
- Device auxiliary switches (FIDs, contactors) should be referenced to the drawings where they are used.
- Any interlocks; electromechanical, key, etc.
- Coil target ratings; on dual ratings underline the appropriate tap setting.
- Complete internals for electromechanical protective relays. Solid-state relays may be shown as a "black box," with power supply and output connections, but manufacturer's instruction book number shall be referenced, and terminal designations shown.
- DC fuses protecting the point of contact relaying and breaker's control circuit shall be monitored for blown fuse or open circuit with a yellow indicating light.
- The trip coils of lockout relays should be monitored.
- The coils and contacts of all timers and lockout relays shall be wired through States links or equivalent terminal blocks to provide isolation for testing.

Front View Diagrams

This drawing will show the physical arrangement of all the control and protective equipment for the POC and IPR relaying and shall contain the following information:

- Nameplates shall be provided for all switches, lights and hand-reset lockout relays for identification.
- The POC and IPR relaying shall be mounted in the POC/IPR cabinet. The POC relays and the IPR relays must be separately labelled.

- The POC and IPR relays shall be mounted in the cabinet in such an order that equipment associated with the various phases will be in A-B-C (PPL EU phase names) order from top to bottom or from left to right when facing front of panel on which they are mounted.

DRAWING REVIEW AND ACCEPTANCE PROCEDURES

- The IPP must submit preliminary relaying drawings for PPL EU review and acceptance. All preliminary metering drawings must be submitted for review and acceptance by the Supervisor, Meter Engineering. These drawings must be submitted before the customer's equipment is ordered to ensure that it meets PPL EU requirements.

- The IPP must submit final relaying drawings for PPL EU review and acceptance before the customer's facilities will be allowed to be connected to the PPL EU system and placed in-service. All final metering drawings must be submitted for review and acceptance by the Supervisor, Meter Engineering. PPL EU will not be held responsible for possible late connection of customer's facilities if drawings are not received in time for review.

- The type of drawings submitted must be according to the list described under "Drawings and Information for Review".

- All drawings submitted to PPL EU for acceptance must contain complete information as outlined under "Contents of Drawings."

- The drawings submitted by the IPP to PPL EU for review apply only to switching devices and POC and IPR relaying.

- PPL EU will review the IPP's drawings and provide comments within 15 working days from the day a complete set of drawings and information are received by Substation Engineering.

- Specific Grading Plan, Foundation Plan, Foundation Details, Conduit Plan, Structural Steel Assembly, and Structural Steel Fabrication Detail drawings do not require PPL EU review.

- The responsibility of detailed and correct design lies with the IPP. Neither PPL EU nor any person acting on behalf of PPL EU:

    - Assumes any responsibility for correctness of design, drawings, installation, or operations.

    - Assumes any liability with respect to the use of, or from damages resulting from the use of, any comments disclosed in this document or in any other PPL EU correspondence with the customer.

FINAL AS-BUILT DRAWINGS

The customer must provide to PPL EU two (2) copies of the As-Built drawings listed in Section 7, under "Drawings and Information for Review". Also include copies of all inspection certificates with the copies.

The 'Final As-Built' drawings can be provided in:

- **Hard copy**
- **Auto CAD format**
- **PDF format**

If providing hard copy, the text must be legible. For example, a 'D' size Drawing (22x34 inches) cannot be submitted as a 'C' or 'B' size final drawing.

NOTE: Final as-built drawings are required to be completed and submitted to PPL EU within 60 days of the initial synchronization of the generation. **Failure to submit such drawings may result in the IPP not being able to interconnect with the PPL EU system until the "as built" drawings are received.**

APPENDIX 1 APPLICABLE ANSI, IEEE, NEMA, NFPA & UL STANDARDS

This document will be applied in conjunction with other industry standards pertaining to generation and PPL EU intertie installations, the latest versions at the time of this revision:

- ANSI/IEEE C12.1-2014, Electric Meters—Code for Electricity Metering
- ANSI C12.20-2015, Electricity Meters—0.1, 0.2 and 0.5 Accuracy Classes
- ANSI/IEEE C37.2-2008, Standard Electrical Power System Device Function Numbers, Acronyms and Contact Designations
- ANSI C84.1-2016, or latest version, Electric Power Systems and Equipment – Voltage Ratings
- IEEE Std. C2-2017, National Electrical Safety Code
- IEEE Std. C37.90.2-2004, IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- IEEE Std. C57.12.00-2015, IEEE Standard for General Requirements for Liquid Immersed Distribution, Power and Regulating Transformers
- IEEE Std. C57.13-2016, IEEE Standard Requirements for Instrument Transformers
- IEEE Std. 80-2013, IEEE Guide for Safety in AC Substation Grounding
- IEEE Std. 81-2012, IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System
- IEEE Std. 315-1975 (R1989), IEEE Standard for Graphic Symbols for Electrical and Electronics Diagrams
- IEEE Std. 487-2015, IEEE Standard for the Electrical Protection of Communications Facilities Serving Electric Supply Locations – General Considerations
- IEEE Std. 519-2014, IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
- IEEE Std. 81-2012, IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System
- IEEE Std. 1547.1-2005, or latest version, Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems
- IEEE Std. 789-2013, IEEE Standard Performance Requirements for Communication and Control Cables for Application in High Voltage Environments

- NEMA Standard ICS-6 1993 (R2016), Industrial Control and Systems: Enclosures
- NFPA 70-2017, National Electrical Code
- UL 1741-2010, Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources

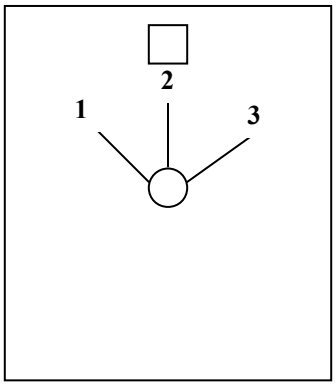
APPENDIX 2 DETAILS FOR PPL EU CONTROL SWITCH (PCS)

Below is a TYPICAL control switch development showing the required functions. This information is taken from a General Electric type SB-1 switch (model no. 16SB1B2X2), but alternative suppliers and models with the same functionality will be considered.

The switch is to have a PISTOL grip handle, with a target (or flag) indicator, and to be spring-return from the close to the normal position and from the trip to the normal position. The target (or flag) will indicate RED for the Normal After Close position, and GREEN for the Normal After Open position. The positions will be Trip, Normal, Close, from left to right when viewed from the front of the switch. The trip and close position should be approximately 45 degrees off of vertical, and the normal position will be the vertical position.

Contact	#	Close (3)	NAC (2)	NAT (2)	Trip (1)
1 1C	1	X			
2 2C	2				X
3 3C	3	X			X
4 4C	4	X			
5 5C	5		X	X	
6 6C	6				
7 7C	7	X	X		
8 8C	8	X	X		

FRONT VIEW:



ESCUTCHEON ENGRAVING:

1 TRIP
2 * (NAT and NAC)
3 CLOSE

NOTE: The Normal After Trip (NAT) and Normal After Close (NAC) position are not engraved.

LOCATION CODES: R074, R073

APPENDIX 3 ITEMS TO BE DISCUSSED DURING THE PROJECT

This is a list of items that *generally* need to be addressed during a typical project. It is NOT all inclusive--nor is it any particular order--and is provided as a guide only.

1. REQUIRED ELECTRICAL INSPECTIONS
As required by local ordinances, authority having jurisdiction or other PPL EU requirements to meet the NERC FAC-001 Standard.

2. PLANT OPERATION
The IPP should meet with PPL EU to discuss effect of plant operation on which breaker is tripped, and how the IPP will maintain critical services during extended line outages.

3. ALTERNATE SUPPLY OR TWO-LINE SUPPLY
Check to see if the IPP requires an alternate supply of power to aid in powering the plant, or to allow operation during outages of the normal source.

4. POC BREAKER CONTROLS
Determine how the POC (Point of Contact) breaker is to be controlled--tripped by POC, IPR, PCS, DTT, etc. devices.

5. CONTROL SCHEME--DC
Confirm that a DC voltage control scheme will be specified for the IPP customer's facility and discuss the DC source.

6. AUXILIARY LOADS
Get the minimum and maximum auxiliary loads, and the amounts of load the PPL EU system will be expected to pick up immediately after a unit trip.

7. FLICKER/HARMONIC PRODUCING LOADS
Get data from the generator for all loads connected to the PPL EU system capable of producing flicker or expected to have substantial harmonic content.

8. PERIODIC RELAY SETTINGS
Discuss the arrangement for PPL EU Test Department to periodically test the POC and IPR relays.

9. PLANT ACCESS
Set up procedure for PPL EU access to the various pieces of PPL EU equipment (relays).

10. GENERAL OPERATING PROCEDURE GENERATOR
Review the IPP's general operating procedure to see if there are any conflicts with the PPL EU system operation.

11. VOLTAGES AT GENERATOR
Notify the IPP of the expected voltage levels at this location; review with this transformer information, especially the transformer taps.

12. FAULT DUTIES AND SHORT CIRCUIT LEVELS
Send out the latest estimate of the fault duties at the IPP's location.

13. CONSTRUCTION POWER
The IPP is required to contact the PPL EU field coordinator to arrange for construction power.

14. START UP POWER
Check to see when start up power is required for testing; this is usually several months before the synchronization date.

15. POC AND IPR CABINET
Send out the list of the specific protection and control requirements for this location. Check on the location of the POC and IPR cabinet, switchyard, control room, other? Discuss the design of the cabinet, the front view and location of various components in the cabinet—the cabinet must be designed so the PCS switch, the POC relays, the IPR relays and other components can be secured via PPL EU padlock on the cabinet door. The IPP must have access to read and reset the relay targets without unlocking the cabinet.

16. POC AND IPR RELAYS
Send the IPP a list of the preliminary relay ranges and setting, after receipt of the one line from the IPP. Review the list of specific relays to be supplied for the POC and IPR cabinet, check the manufacturer, ranges, etc. Confirm that all relay inputs and outputs can be isolated by test switches (FT-1 or equivalent) or use draw-out cases.

17. SOLID GROUNDING
Notify the IPP that the connection for the transformer will be solidly grounded WYE on the high side, unless otherwise agreed to by PPL EU.

18. POC AND IPR INTERLOCKS
Review the operation of the PPL EU control switch (PCS) on the breaker used to isolate the generator from the system.

19. SYNCHRONISM CHECK RELAY
Verify that the IPP has implemented the synchronism-check relay correctly, and that any breaker which can parallel the generator to the PPL EU system has the synchronism check function in the closing circuit.

20. DRAWING REVIEW--ONE LINE
Review the initial IPP facility one line; check for compatibility with the PPL EU system

21. DRAWING REVIEW--THREE LINE
Review location of CT's, PT's, metering, and other major equipment. Check the phasing of the IPP system and the POC and IPR relays vs. the PPL EU system. Also check the phase names of the IPP vs. PPL EU, on the terminal pole or dead-end structure.

22. DRAWING REVIEW--SITE PLAN

Review the site plan, for location of various major pieces of equipment; dead-end structure, the last PPL EU pole etc. Review PPL EU line crossings, and the layout of the fence, and the property lines. Whose property is the tap on?

23. DRAWING REVIEW--SUBSTATION

Review grounding details. The customer neutral/ground must connect to the PPL EU system neutral. The conductors must be capable of handling the fault current. For high voltage installations, the measured ground resistance **prior to the connection of any outside facilities** must 5 ohms or less. Check on the location of lighting arrestors, also voltage rating and class. Review the point of contact switch (POC), location, operation, rating, and manufacturer. Also, the switch must be capable of being locked in the open position.

24. DRAWING REVIEW--CONTROL ELEMENTARY

Review the POC and IPR DC control elementaries and interlocks. Also, review the use of auxiliary or lockout relays. Verify the operation of all breakers, especially breakers that must be interlocked to avoid a misoperation of the synchronism schemes.

25. DRAWING REVIEW--POC CB

Determine the type of breaker (oil, air, magnetic, etc.) and ratings (continuous, duty, fault, and operating time). Check tripping and closing logic--pay special attention to the synchronizing and synch check circuits.

26. DRAWING REVIEW--LOW SIDE GENERATOR BREAKER

Check to see that the breaker is suitable for the intended operation. Will this breaker withstand 2 per unit voltage in the open condition? Check tripping and closing logic--pay special attention to the synchronizing and synchronism check circuits. Check CT and CCVT device ratings.

27. DRAWING REVIEW--POTENTIAL

Review the potential elementary for the correct phasing and voltage levels to PPL EU protection equipment. Check the location of the neutral grounds in these circuits and that there is only one ground per circuit.

28. DRAWING REVIEW--CURRENT

Review the current elementary; check the CT ratios and connections to PPL EU equipment. Check the location of the neutral grounds in these circuits and that there is only one ground per circuit.

29. DRAWING REVIEW—PROTECTION EQUIPMENT WIRING

Review the protective relay schemes for any gross errors. **PPL EU does not review** the wiring drawings in detail.

30. SYSTEM DESIGN

Review the length of the CT, PT, and DC cables, the connected burden, and the calculated voltage drop. Review the DC system, voltage level (48 or 125 VDC), minimum designed operational voltage level, fusing and the primary/backup supplies. Check use of the PPL EU synchronism check relay, and location of the relay. Review the need for breaker failure protection at the generator and review the implementation. Look into the possibility of installing a breaker 'a' switch to block voltage and frequency relays when the generator is off line to avoid nuisance trips.

Facilities connected at high voltages will need to consider: insulation coordination, equipment ratings, operating considerations.

31. VOLTAGE REGULATOR
Notify the IPP of the required modes of operation; check the voltage regulator for the required functions.

32. USE OF CONTACT MULTIPLYING RELAYS
If contact multiplying relays are used in any schemes associated with PPL EU controls, they must be designed for fail-safe operation.

33. METERING EQUIPMENT
Review with the IPP who will supply the various pieces of equipment, and who will install this equipment. Check on the location and type of equipment indoor vs. outdoors, metering cabinet vs. switchgear. Determine when the IPP will need the PPL EU metering equipment.

34. BATTERY MONITOR--27DC
It may be necessary to add a time delay to the battery monitor, so that it will not operate when various pieces of DC equipment are operated.

35. RELAY TARGETS
Make arrangements for the Test Department to mark the appropriate targets with a PPL EU ID number.

36. DESCRIPTION OF OPERATION – IPP FACILITIES
Discuss who will write up a description of the control facilities, including POC, IPR, DTT, and trip and blocking points, based on specific information provided by the IPP.

37. VOLTAGE/REACTIVE SCHEDULE
Review the voltage/reactive requirements for the IPP; see that the IPP receives and understands this information.

38. VOLTAGE REGULATOR
Obtain a description of the voltage regulator, voltage and VAR control equipment.

39. GUIDELINE FOR VOLTAGE/REACTIVE CONTROL
Be sure a guideline is created which details acceptable deviations and the action to be taken for excessive deviations.

40. 5% VOLTAGE REDUCTION
Notify the IPP of the possibility of 5% voltage reductions conducted during severe high-load periods.

41. SPARE PARTS – POC and IPR SCHEMES
Inform the IPP of PPL EU's position not to carry spare parts for the POC and IPR cabinet, also determine which components are critical to the continued operation of the IPP's facilities. List the items for which failure will require the shutdown of the IPP.

42. INITIAL SYNCHRONISM
Review the plans for the initial plant synchronism to the PPL EU system. Test Department will observe but not take an active part.

43. REVIEW OF MAIN TRANSFORMER SPECIFICATION
Check for appropriate taps, impedance, windings, grounding, etc.

44. PROJECT SCHEDULE
Get a copy of the proposed project schedule from the IPP to see if there is any impact with PPL EU work.

45. PPL EU REVENUE METERING EQUIPMENT
Send out metering equipment information or cut sheets.

46. SUBSTATION CONTROL HOUSE VENTILATION
Make sure there is adequate ventilation in the building housing the POC and IPR cabinet. This is especially true if the battery is housed in the same room.

47. TECHNICAL CONTACT
Get name, address, and phone number of the contact for the project, as well as for future technical issues after the IPP's facilities are placed in service.

48. DTT REQUIREMENTS
PPL EU will provide specific information on the DTT to be installed, as the equipment installed at the IPP facilities must match equipment installed at the intermediate switchyard and/or PPL EU remote substation. Also, determine the communication channel used for the DTT scheme and obtain specific information for this communication channel associated with the DTT equipment.

49. DRAWING CROSS REFERENCE LIST
PPL EU will issue the 'as built' drawings from the IPP as the drawings of record for the facility. These drawings will be listed by the PPL EU drawing numbers and the IPP drawing number will be cross referenced when the final set of drawings are issued.

50. PROCEDURE IF THE POC, IPR or DTT RELAYING FAILS
Describe the 10-hour rule for repair of the POC, IPR or DTT relay packages.