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Chapter 7 – General Specifications for Rotating Non-Utility Generators (NUGs)

1. Document Scope

The purpose of this document is to communicate the process and requirements for interconnecting a spinning generator to PSE&G's electric distribution system. It should be used as a reference tool to help understand the different aspects involved with the process. Always consult with a qualified PSE&G associate before starting a project. This document will cover the basic elements related to:

- Definitions
- Process
- Applicant/Facility Requirements
- Metering
- Installations in Network Areas

2. Definitions/Acronyms

2.1 Affected System

An electric system other than the PSE&G System that may be affected by the proposed NUG interconnection.

2.2 Aggregate Net Metering

A customer-generator with multiple facilities of the same rate class utilizing one of those facilities as a host site which produces more electricity than consumed at that site.

2.3 Applicant

Within this document the applicant may be several different parties involved with the process of interconnecting. For simplicity's sake, the applicant may be any person or designee taking ownership of and responsibility for the construction, operation, ownership and maintenance of the facility.

2.4 Customer-Generator Facility

Equipment used by a customer-generator to generate, manage and/or monitor electricity.

2.5 E1 Notification

Refers to a formal request for information concerning all customer needs that is created in PSE&G's Distribution Work Management System (**DWMS**).

2.6 EDC

Electric Distribution Company

2.7 ESOC

PSE&G's Electric System Operations Center

2.8 IEEE 1547

Approved series of interconnection standards developed by the Institute of Electrical and Electronics Engineers.

2.9 Interconnection Application and Agreement

Contractual agreement between the customer-generator and PSE&G to interconnect distributive generation to PSE&G's distribution system.

2.10 Interconnection Point

The point(s) of physical connection of the NUG to the PSE&G System located at the point where the PSE&G System meets with and connects to the NUG's facility. Typically, this occurs at the point where the NUG's incoming line is terminated by PSE&G, such as at a disconnect switch or switches on the high side of a customer's circuit breaker or other load break device. This interconnection point or points should be identified on the NUG's single line diagram. This is also the point where certain SCADA and telemetering measurements should be effectively determined.

2.11 Net Metering

A system of metering electricity in which PSE&G:

1. Credits a Customer-generator at the full retail rate for each kilowatt-hour produced by a Class 1 renewable energy system (see Section 2.16 below), installed on the Customer-generator's side of the electric revenue meter, up to the total amount of electricity used by that Customer during an annualized period; and
2. Compensates the Customer-generator at the end of the annualized period for any remaining credits, at a rate equal to the electric supplier's or BGS provider's avoided cost of wholesale power.

   Net Metering rules are included in Section 15 – Net Metering Installations (including all subsections) of the *Electric Standard Terms and Conditions*.

2.12 Non-Utility Generator (NUG)

Non-Utility Generator (also known as a cogenerator, "Distributed" or "Dispersed" Generator (**DG**), Distributed Resource (**DR**), or customer-generator) is any facility which operates an electric power generating device in parallel with the PSE&G System. Large generators that are Independent Power Producers (**IPPs**) or Electric Wholesale Generators (**EWGs**) generally are connected to the Transmission System, will have additional requirements, and come under the interconnection procedures of PJM. There are two basic types of NUGs, one which will sell power to PSE&G (or some other utility) – referred to as an "exporter" and one which will consume all power generated on their own premises – a "non-exporter". There is a subset of exporting facilities which is called a "net metered" facility, where excess power is netted against the customer's kilowatt-hour usage via special metering.

A rotating NUG can be any one of the following types:

- Cogeneration or Combined Heat and Power (**CHP**) Facility

  Produces electricity and useful thermal energy from the same fuel source.
- Resource Recovery Facility

  Produces electricity from fuels such as municipal waste, tires, sludge, wood chips, etc.

- Biopower

  Produces electricity through the use of organic materials
- Hydro Facility

  Produces electricity from water resources
- Landfill Gas Facility

  Produces electricity from natural gas by-products emitted from landfills
- Wave or tidal facility

  Produces electricity from a generator utilizing tidal and wave energy

2.13 PEP

Purchase Electric Power – Agreement to generate electric power and sell directly back to the EDC.

2.14 PJM

The PJM Regional Transmission Organization, which oversees the operation of the transmission system in the region in which PSE&G operates, also has oversight of generator interconnections where the generator is exporting power for use in the wholesale marketplace. Generally, the exporting generation facility must have an aggregate output of over 1 MW to be PJM jurisdictional, and it can be connected to either the distribution system or the transmission system.

2.15 PSE&G System

The electrical facilities owned, controlled and operated by PSE&G.

2.16 Renewable Energy

Class 1 Renewable:

- Biopower
- Fuel Cells (Inverter based – see Chapter 11)
- Stored electrical generation (Inverter based – see Chapter 11)
- Solar or Photovoltaic Facility (Inverter based – see Chapter 11)
- Wave or Tidal
- Wind Facility (Inverter based – see Chapter 11)

Class 2 Renewable:

- Energy produced at resource recovery or hydro power facility

2.17 SCADA

Supervisory Control and Data Acquisition

2.18 Studies

The following studies may be performed by PSE&G in order to determine the capability of interconnecting the NUG facility:

- Feasibility Study

  A basic assessment by PSE&G of the ability of the PSE&G System to accommodate the NUG's interconnection, including preliminary information about what service voltage level would be utilized and costs.

- Impact Study

  An assessment by PSE&G of:

  a. The adequacy of the PSE&G System to accommodate the output of the NUG;

  b. Whether any additional costs may be incurred in order to design, furnish, and install the interconnection; and

  c. With respect to an interconnection application, an estimate of the NUG's cost responsibility for PSE&G's interconnection facilities.

- Facilities Study

  An engineering study conducted by PSE&G (in coordination with any Affected System) to determine the required modifications to the PSE&G System, including the cost and the time required to design, furnish and install such modifications, as necessary to accommodate an interconnection application.

3. Process

3.1 Introduction

The NUG's primary function is to produce electric power that can be used in one of three ways:

- All used on site (Non-Exporter)
- All sold (Exporter)
- A combination of the above, which may include facilities that net meter their output

PSE&G has the following obligations to NUGs:

- Analyze interconnection requests received from NUGs, or PJM in the event that PJM is managing the interconnection process, and provide data and cost estimates.
- Provide access to the PSE&G System.
- Provide regular Electric Tariff service if needed, and billing metering.

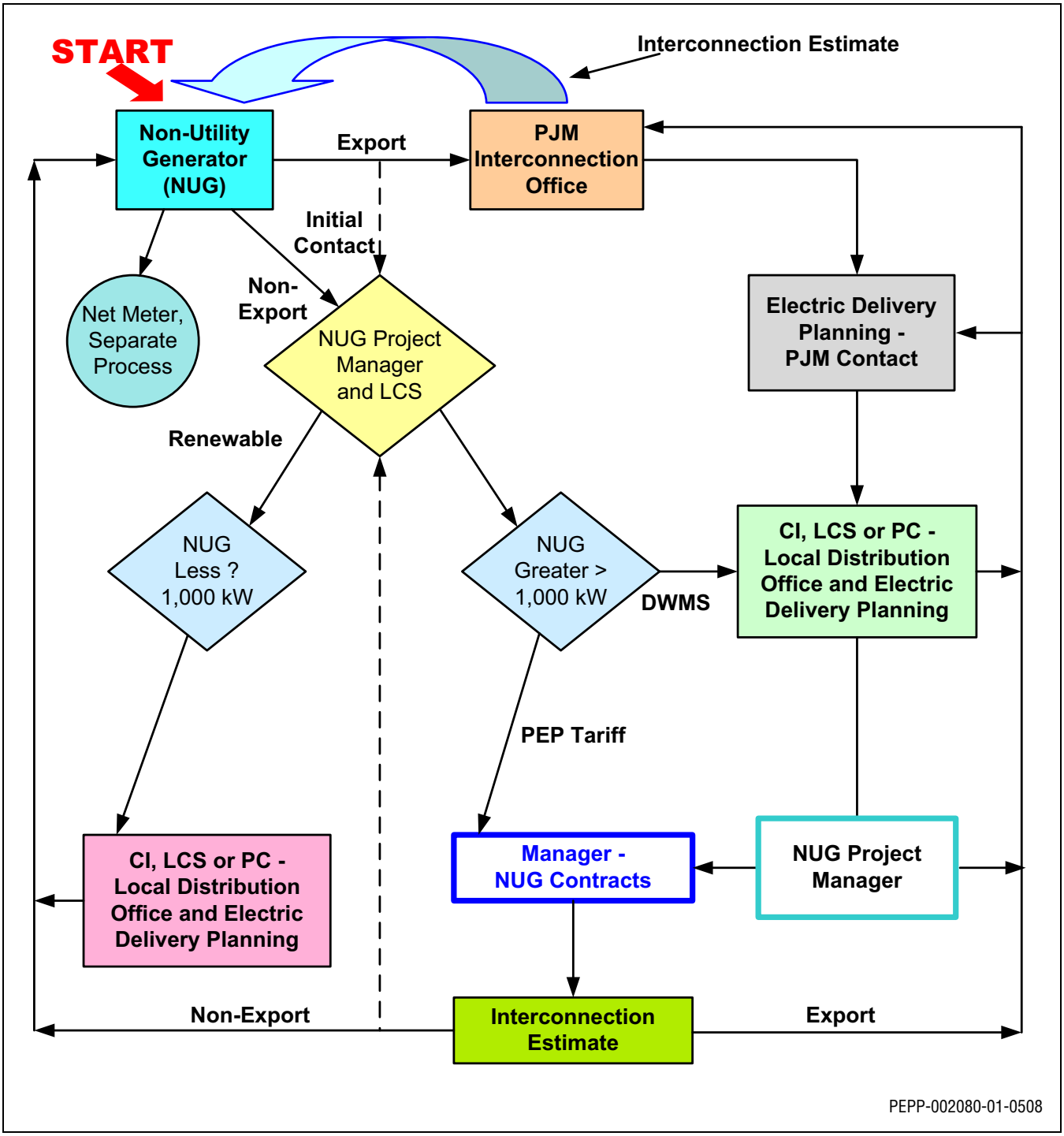
The first contact with PSE&G by a NUG could be received from any of several PSE&G representatives who have responsibility for customer contact. From that initial contact it is important that the NUG be channeled to the appropriate party in PSE&G. The flow chart shown in Figure 7.1 in Section 3.2, "Processing Requests from Rotating Non-Utility Generators not Utilizing Class 1 Renewable Fuels", defines where a NUG should be directed and how various groups in the company are involved with NUGs.

NUGs that utilize Class 1 renewable fuels, qualify for treatment under New Jersey's "*Net* Metering *and Interconnection Standards for Class 1 Renewable Energy Systems*." Separate procedures and processes for tracking these projects have been developed, including specialized metering equipment and billing methods. This topic is covered in Section 3.3. More on Class 1 Renewable Energy interconnections may be found in Chapter 9 of Technical Manual "*Information and Requirements for Electric Service Manual* (Green Book), Rev. 03.00, Dated May 31, 2014."

3.2 Processing Requests from Rotating Non-Utility Generators not Utilizing Class 1 Renewable Fuels

The following flow chart (see Figure 7.1) represents the procedure for handling a service request from a rotating Non-Utility Generator that is not covered by the Net Metering regulations referenced above.

Figure 7.1: Typical Flow Chart



1. Flowchart Terms
   - Non-Utility Generator (**NUG**)

     The owner/manager/engineer of the facility, consultant, contractor, or anyone acting or working as an agent of the owner.
   - Initial Contact
   - All initial contacts with the NUG will be referred to the Business Process Manager in the Springfield Office (Large Customer Support Department). Based on the size of the co-generator the following course of action will be determined:
     - >2 MW – initiate and coordinate an initial meeting of all parties, unless the project will be managed by PJM.
     - ≤2 MW send information to the local Electric Distribution Division office and Electric Delivery Planning.
   - Initial Meeting of all Parties

     For the NUG with greater than 2 MW capacity and that is not being managed by PJM, the Major Account Consultant will arrange a meeting of all persons who will have an interest in the project, to include any or all of the following:

     i. The Non-Utility Generator
     ii. Manager – NUG Contracts
     iii. Manager – Transmission Planning
     iv. Manager – Electric Delivery Planning
     v. Major Account Consultant
     vi. Operations and Resource Manager
     vii. ESOC and/or Division Operations
     viii. Manager – Asset Reliability
     ix. NUG Project Manager

     The initial meeting will be used to obtain and pass on information needed for the customer to:
2. Determine if it may be feasible to construct the facility.
   a. Establish lines of communication for the project.
   b. Exchange information with the NUG to establish project scope. The NUG will be informed that an Agreement for the project will need to be executed. Additionally, detailed specifications and requirements will be prepared when the project is approved and the required contribution is received.
   c. Inform the NUG whether or not it should be applying for its interconnection through the PJM process.
      - NUG Project Manager

        Responsible for the entire project, including preparation of Investment Request (**IR**) and obtaining funds, within their department.
      - Interconnection Estimate

        Information required by involved parties to complete the project. Included will be information such as study estimates, conceptual estimates, plans, specifications, drawings for review, payment schedules, construction schedules, cut in procedures, etc.

3.3 Processing Requests from Rotating Non-Utility Generators Utilizing Class 1 Renewable Fuels

All current rules for interconnecting NUGs using Class 1 renewable fuels with a local electric distribution company in New Jersey is described in The New Jersey Administrative Code (**N.J.A.C.**) Subchapter 5 – "Interconnection of Class 1 Renewable Energy Systems" Sections 14:8-5.1 through 14:8-5.9.

This section outlines the framework for processing interconnection applications based on above-mentioned N.J.A.C. regulations to ensure that applicants are aware of the PSE&G Standardized Interconnection Requirements (**SIR**). This section also provides applicants with an understanding of the process and information required to permit PSE&G to review and accept the applicants' equipment for interconnection in a reasonable and expeditious manner.

The time required to complete the process will reflect the complexity of the proposed project. Projects using previously submitted designs that have been satisfactorily accepted will move through the process more quickly, and several steps may be satisfied with an initial application depending on the detail, completeness of the application, and supporting documentation submitted by the applicant.

The application process and associated services are offered by PSE&G on a non-discriminatory basis. **The applicant is responsible for all costs that PSE&G would not have incurred but for the applicants' interconnections**.

See Section 3.3.1 for general overview.

3.3.1 N.J.A.C. Level Review Process

For rules regarding interconnection of rotating NUGs utilizing Class 1 renewable fuels, the N.J.A.C., Sections 14:8-5 and 14:8-6 may be applied. The latest version of the regulations is available from the following website:

http://www.state.nj.us/oal/rules.html

http://www.lexisnexis.com/hottopics/njcode/

The level of interconnection is defined in N.J.A.C. by the power rating of the NUGs which also sets out specific evaluation criteria as follows:

Interconnection Level	System Rating	N.J.A.C. Requirements
Level 2	> 10kW up to 2MW	14:8-5.5
Level 3	> 2MW	14:8-5.6

3.3.2 Level 2

Each EDC shall adopt a Level 2 interconnection review procedure. The EDC shall use the Level 2 interconnection review procedure for an application to interconnect a customer-generator facility that meets both of the following criteria:

1. The facility has a capacity of two megawatts or less; and
2. The facility has been certified in accordance with N.J.A.C. 14:8-5.3.

3.3.3 Level 3

Each EDC shall adopt a Level 3 interconnection review procedure (which is described in N.J.A.C. 14:8-5.6). The EDC shall use the Level 3 review procedure for an application to interconnect a customer rotating generator facility that does not qualify for the Level 2 interconnection review procedures set forth at N.J.A.C. 14:8-5.5.

3.3.4 Application Documentation

The documents and application fees required from a customer vary depending on the type of interconnection being proposed. The relevant documents are outlined below:

Interconnection Type	Interconnection Document
Net Metering Level 2-3	Level 2-3 Interconnection Application/Agreement (with Terms and Conditions)*
PEP Tariff – Levels 1-3	Level 2-3 Interconnection Application/Agreement (with Terms and Conditions)*
PJM Tariff	N/A (Requests processed through Electric Planning group)

*Application/Agreement documents and fees can be located at PSE&G's Website, or the NJ Office of Clean Energy Website:

http://www.pseg.com/business/small_large_business/rebate/njcleanenergy.jsp

http://www.njcleanenergy.com/renewable-energy/programs/net-metering-and-interconnection

Additional documentation required, but not limited to, includes:

- Site plan including the location of proposed interconnection point
- Electrical one-line including both the utility feed and customers equipment
- Detailed switchgear specifications

3.4 Application Review

A PSE&G representative will process the application for an initial review and feasibility study. This requires a basic assessment of the ability of the PSE&G System to accommodate the customer-generator's interconnection, including preliminary information about what service voltage level would be utilized and costs. The results of this study will determine whether or not an impact study and or facilities study will be required.

The applicant will be provided with an assessment of the technical feasibility of the proposed interconnection and proposed costs that may be incurred.

If it is determined that there may or will be a significant impact to the utilities PSE&G's distribution system, the customer will be informed that further study will be necessary. The applicant will then be required to:

- Provide PSE&G with a cost-based advance payment for the PSE&G review of the proposed generator.
- Submit a detailed design package.
- Confirm with PSE&G a mutually agreeable schedule for the project based on the applicant's work plans and the other discussions.

Additional exchanges of information between PSE&G and the applicant may be required to complete the design package according to PSE&G's technical requirements for interconnection.

Applicant will be informed of the results of any further studies and issued an estimate for all necessary work to accommodate the customer-generator's interconnection.

3.5 Applicant Commits to Proceed with Constructing the Project

The applicant will:

- Execute a standardized interconnection agreement or commit in writing to the applicable tariff requirements.
- Provide PSE&G with an advance payment for PSE&G's estimated costs associated with system modifications, metering, and on-site verification.
- Provide a preliminary schedule of construction for the facility.

3.6 Coordination and Scheduling

The applicant will be provided with the contact information for the applicable PSE&G representative. The applicant shall contact this individual to schedule a project kick-off meeting.

At this initial meeting the applicant should be prepared to discuss:

- Scheduling
- Details of related documentation and drawings submitted
- Coordination
- Inspection requirements
- Metering requirements

3.7 Inspection and Testing

Periodic inspection will be required by our metering and inspection department. Scheduling of these site visits should be discussed at the bi-monthly meetings and will be the responsibility of the applicant. See Section 4. for further details of the inspection process.

The applicant will develop a written testing plan to be submitted to PSE&G for review and acceptance. This testing plan will be designed to verify compliance of the facility with the applicant's PSE&G-accepted drawings and details of the interconnection. The final testing will include testing in accordance with the SIR and the site-specific requirements. The final testing will be conducted at a mutually agreeable time and PSE&G shall be given the opportunity to witness the tests. See Section 4. for further details off the testing protocol.

When applicant is ready to schedule a testing date, they should have completed the second part of the Interconnection Agreement and submitted it to PSE&G.

3.8 Acceptance

Within a reasonable time after interconnection, PSE&G will review the results of its on-site verification and issue to the applicant a formal letter of acceptance for interconnection or Permission To Operate (**PTO**) as well as a copy of the fully executed agreement.

Installation of the customer-generator facility must be in compliance with the local, state and federal codes and regulations, and shall meet the requirements of IEEE Standard 1547-2003 (R2008) "Standard for Interconnecting Distributed Resources with Electric Power Systems" with the Amendment IEEE Std 1547a™-2014 and any subsequent subparts of IEEE 1547, such as IEEE 1547.1 (2005) for testing protocols. The installation shall be performed in a workmanlike manner, and shall meet or exceed industry standards of good practice. Prior to connection, PSE&G must be provided by the local Sub-code Official with a "cut-in

card" or other evidence of the satisfactory electrical inspection by the authorized inspection agency having jurisdiction.

Note

PSE&G will not be liable for damages or for injuries sustained by customers or by the equipment of customers or by reason of the condition or character of customer's facilities or the equipment of others on customer's premises. PSE&G will not be liable for the use, care, or handling of the electric service delivered to the customer after same passes beyond the point at which PSE&G's service facilities connect to the customer's facilities.

Upon initial parallel operation of a generating system a "Witness Test" or verification test shall be performed, or any time interface hardware or software is changed, a verification test must be performed in accordance with the applicable requirements of IEEE Std 1547.1 (2005) "Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems." A New Jersey Licensed Professional Engineer or qualified individual working under the direction of a New Jersey Licensed Professional Engineer must perform verification testing in accordance with the manufacturer's recommendations, and use licensed electricians with experience in testing protective equipment. PSE&G reserves the right to witness verification testing or require written certification that the testing was performed.

Verification testing shall be performed every 4 years. All verification tests prescribed by the manufacturer shall be performed. If wires must be removed to perform certain tests, each wire and each terminal must be clearly and permanently marked. The generator-owner shall maintain verification test reports for inspection by PSE&G.

Any system that depends upon a battery for trip power shall be checked and logged once per month for proper voltage. Once every 4 years the battery must be either replaced or a discharge test performed.

3.9 PSE&G Modifications

All labor and material expenses incurred to provide the NUG interconnection service will be billed at actual cost.

4. Applicants/Facility Requirements

The following are requirements for all NUGs regardless of size or intent to sell to PSE&G or elsewhere, other that those which are handled under the Net Metering program.

The information contained herein is general and not intended to cover all details and aspects of a particular project. PSE&G should be consulted in case of doubt on the current applicability of any item.

Any information contained in this document is subject to change without notification. It is the NUG's responsibility to verify current applicability of information through written inquiry to PSE&G.

It is PSE&G's policy to permit NUGs to operate their generating equipment in parallel with PSE&G's electric distribution system provided there are no expected adverse effects to the reliability or quality of service currently provided to other customers, or to the safety of PSE&G's workers or the general public.

4.1 Drawings and Specifications

Three sets of the following drawings must be submitted to PSE&G and/or PJM for review:

1. AC three line schematics detailing the required relaying and CT location.
2. DC schematics detailing the required relaying.
3. Instruction manuals for the protective components.
4. One line diagram showing the interconnection with the PSE&G system as well as the generator and associated breakers and protective equipment.
5. Generator data required to analyze fault contributions and load flows.
6. Transformer data including ratings and impedance. All transformers for all NUG facilities, inclusive of customer owned transformers on net metered facilities, **must** by wye-wye type. There must be a ground connection on the utility side of each transformer. Any deviation from this requirement **must** be approved by PSE&G.
7. Logic diagrams and/or tripping tables.

4.2 Trench, Conduit and Conductors

The applicant will be responsible for all trench, conduit and secondary conductors required. Primary conductors will be provided and installed by PSE&G at the applicant's expense. It is the applicant's responsibility to conform to all PSE&G and NEC specification requirements for trench and conduit installation as well as coordination of all inspections required for such work.

4.3 Telecommunication

The applicant is responsible for all telecommunication conduit and conductors. The applicant is also responsible for all coordination and communication with the telecommunication company.

4.4 Switchgear

For NUGs directly connected to 4 kV and higher voltages the applicant is responsible for the supply and installation of all required switchgear elements. The switchgear must strictly conform to PSE&G's specifications.

4.5 Disconnect Switch

A disconnect switch may be required depending on the size of the installation. It is recommended to be installed on both sides of PSE&G metering for most installations.

4.6 Automatic Control

The protective equipment installed by the NUG shall provide automatic disconnection of the generator from the PSE&G System for the following conditions.

1. A fault on the NUG equipment
2. Abnormal voltage or frequency
3. De-energization of the PSE&G supply line

In addition, the NUG must submit plans explaining how their control scheme will isolate its generation from the PSE&G System when the PSE&G source is lost.

4.7 Breaker Control

For NUG's supplied at voltages of 4 kV or greater, the high side breaker must be DC operated. This will require a battery and suitable charger. It has been the experience of PSE&G that a properly maintained battery provides the most reliable source of power for operating breakers. The battery shall be sized for a minimum of 8 hour duty cycle. The NUG is responsible for maintaining the battery and charger system.

4.8 Isolation for Testing

At NUG's whose aggregate output exceeds 1 MW, all required relays shall have provisions for AC and DC isolation for testing. This will normally consist of test switches such as the ABB FT-1. The current circuits must have shorting bars to avoid open circuiting the Current Transformers (**CTs**).

4.9 Telemetering, SCADA and Control

4.9.1 Telemetering

Equipment shall be installed at the Project and PSE&G's Electric System Operations Center (**ESOC**) in Newark, New Jersey to provide for telecommunication interfaces and to enable measurement of the following quantities when the NUGs net output into PSE&G's System will exceed 1,000 kW:

1. Instantaneous net active electrical power output of the Facility's generator
2. Instantaneous net reactive electrical power output of the Facility's generator
3. Instantaneous terminal voltage of the Facility's generator
4. Instantaneous voltage at the Substation Facility
5. Instantaneous active power flow on the Interconnection at the Substation Facility
6. Instantaneous reactive power flow on the Interconnection at the Substation Facility
7. Hourly kilowatt-hours of Net Electrical Energy received by PSE&G at the Point of Interconnection.
8. Based upon PSE&G's review of the design of the electrical portion of the Project, PSE&G will designate the point(s) where the aforementioned electrical quantities are to be measured.

PSE&G shall designate, select and specify the equipment and subsequent telecommunications devices to be used for telemetering to the ESOC by means of fiber optic cable, digital data links and/or analog signals to be installed at the facility, to enable a measurement of the aforementioned electrical quantities. PSE&G shall purchase the telemetering and control equipment required at both the Project and the ESOC, at the NUG's expense. The NUG shall receive from PSE&G and install the telemetering equipment required at the Project in accordance with PSE&G's specifications. PSE&G shall own, operate and maintain the telemetering and SCADA equipment.

The NUG shall pay PSE&G for any costs associated with operating and maintaining the telemetering and SCADA equipment.

For projects 10 MW or less in size that are coordinated through PJM, PSE&G and the NUG may choose to utilize PJM's telemetry format, which is discussed in Attachment E to PJM Manual 14A, Rev.17, effective 1/22/2015.

4.9.2 Supervisory Control and Data Acquisition (**SCADA**)

For all NUGs with net output into PSE&G's System above 1,000 kW PSE&G shall designate, select, specify and purchase the equipment required for SCADA purposes. The NUG shall receive the devices from PSE&G and install the equipment at its facility. If necessary, PSE&G will install any other SCADA equipment required at its facilities, at the NUGs expense. The NUG shall pay PSE&G for all costs associated with SCADA equipment. This equipment will provide some or all of the following data:

1. Entrance breaker status indication
2. Breaker low gas pressure alarm
3. Breaker control status indication (local/remote)
4. Main transformer differential relay operation alarm indication
5. Generator breaker status indication
6. SCADA equipment shall be capable of tripping the generator breaker or the entrance breaker.

Additional SCADA equipment for use by the local Electric Distribution Division office operations personnel may be required. This local-use SCADA equipment utilizes low cost equipment, but can provide some or all of the following data as needed:

1. Circuit breaker open/close indication
2. Line disconnect switch open/close indication (NO or NC)
3. RFL receive trip (for transfer trip relaying)
4. RFL trouble alarm (for transfer trip relaying)
5. Loss of potential
6. Bus voltage (three phases)
7. DC control low voltage alarm

For projects 10 MW or less in size that are coordinated through PJM, PSE&G and the NUG may choose to utilize PJM's SCADA system, which is discussed in Attachment E to PJM Manual 14A, Rev.17, effective 1/22/2015.

4.9.3 Telecommunications

Non-Utility Generator shall lease, at its expense the appropriate communication circuits required for operation of the SCADA system.

Such equipment will be owned, operated and maintained by PSE&G. Any costs associated with the operation or maintenance of such equipment shall be paid for by the NUG within 30 days of the date of billing.

For projects 10 MW or less in size that are coordinated through PJM, PSE&G and the NUG may choose to utilize PJM's communications system, which is discussed in Attachment E to PJM Manual 14A, Rev.17, effective 1/22/2015.

4.10 Power Factor

The power factor of the NUG must be maintained at unity at the Interconnection Point unless otherwise specified by PSE&G. The generator shall have the capability to operate between 0.95 lagging, to 0.95 leading if required by PSE&G for operational purposes. The installation of power factor correction capacitors at the NUG's generating facility may be required if the output is below unity and cannot be corrected by the generator. The cost of such capacitors shall be borne by the NUG.

4.11 Relaying

The Non-Utility Generator interconnection relay settings shall be set based on IEEE Standard 1547-2003 (R2008) "Standard for Interconnecting Distributed Resources with Electric Power Systems" with the Amendment IEEE STD 1547a™-2014 and any subsequent subparts of IEEE 1547. PSE&G may provide additional relay requirements superseding the ones from above-mentioned IEEE Standards. PSE&G must approve all the remaining settings for all required interconnection relays that trip breakers that affect PSE&G load flow. In addition, for NUGs whose aggregate output is greater than 1 MW, PSE&G personnel will apply the settings to the relays. However, if preferred by the NUG, or because personnel constraints prohibit PSE&G from applying the settings, this task may be contracted for by the NUG to be performed by a qualified third party acceptable to PSE&G. If a third party applies the settings, documentation showing proof of the setting application shall be provided by the NUG to PSE&G. If PSE&G applies the settings, the NUG will be charged for this service.

For NUGs whose output is greater than 1 MW, periodic maintenance of the required protective relay system may be performed by PSE&G personnel. The NUG will be charged for this service. If preferred by the NUG, or because personnel constraints prohibit PSE&G from performing the required maintenance, it may be performed by a qualified third party acceptable to PSE&G. If a third party performs the maintenance, documentation showing proof of the maintenance shall be provided by the NUG to PSE&G. The period of maintenance shall be based on the PSE&G Relay Test Manual and currently that interval is 4 years.

If the output of the NUG is 1 MW or less, the NUG must provide for periodic maintenance of the protective relay systems and submit proof of this maintenance to PSE&G. The period of this maintenance shall be 4 years or less.

PSE&G recommends that the other relays installed by the NUG also be maintained periodically. The NUG may use a qualified independent testing service or may request that PSE&G perform the testing and maintenance. The NUG will be billed for all testing and maintenance performed by PSE&G on other relay systems at their facility.

When the NUG facility is first placed in service (for a NUG whose aggregate output exceeds 1 MW) PSE&G will test all required interconnection relays and their associated circuits prior to energizing the NUG.

4.12 Relay Requirements

The following requirements are mandated for the safety and reliability of the PSE&G System. The relay protection design of all equipment in the NUG's facility is solely the responsibility of the NUG.

The numbers shown in parenthesis in the following paragraphs utilize the IEEE codes for the particular relay type referenced below.

4.12.1 NUG any Output Power Level – Non-export

A NUG, which does not intend to send power to the grid, shall install a relay with a directional power function (32) at the point of interconnection with PSE&G. Sufficient power must flow into the NUG's facility such that enough current is detected by the CTs that the 32 element can operate. If power flow into the NUG is not maintained, the 32 element will open a breaker between the generator and PSE&G. This method of always importing a small amount of power is required to ensure proper operation of the directional power relay, since whenever the 32 element detects any power flows from the NUG into the PSE&G System, the 32 element will isolate the generator from PSE&G. The relay with a directional power function (32) shall be fed by three single-phase current transformers (**CT**) and three single-phase potential transformers (**PT**) located on the PSE&G side of the service entrance breaker. The PT shall be connected Wye-Wye. In order to

limit unnecessary operations during faults on the PSE&G System or loss of load in the NUG's facility, the directional power relay should be set with up to a 5 second delay (except for the case of generators connected to 4 kV or 13 kV circuits, which has to meet specific relay requirements explained in Section 4.12.5. below).

Since the PSE&G source breaker may be reclosed automatically, it is essential that the NUG generator is disconnected from the utility system when the reclose attempt occurs, or equipment damage can result.

4.12.2 NUG Aggregate Output 1 MW or Less – Export

Except for the case of generators connected to 4 kV or 13 kV circuits, which has to meet specific relay requirements explained in Section 4.12.5 below, any other type of rotating NUG whose total output is 1 MW or less and that intends to export power to the grid is required to provide the following functions in its relay protection design:

1. Undervoltage (27) function
2. Overvoltage (59) function
3. Underfrequency (81u) function
4. Overfrequency (81o) function

The relays specified in items 1-4 above are to be selected from PSE&G's current list of acceptable microprocessor relays (see Section 4.13)

4.12.3 NUG Aggregate Output Greater Than 1 MW – Export

Except for the case of generators connected to 4 kV or 13 kV circuits, which has to meet specific relay requirements explained in Section 4.12.5. below, any other type of rotating NUG whose total output exceeds 1 MW and that intends to export power to the grid is required to provide the following functions in its relay protection design:

1. Undervoltage (27) function
2. Overvoltage (59) function
3. Underfrequency (81u) function
4. Overfrequency (81o) function
5. Voltage controlled overcurrent (51V) or generator differential (87) function

The relays specified in items 1-4 above are to be selected from PSE&G's current list of acceptable microprocessor relays (see Section 4.13)

Relays specified in item 5 above are generator protection relays. Their settings are based on type of relay selected. These settings and relays do not need PSE&G approval.

4.12.4 Additional Equipment

In addition to the relays mentioned in the preceding paragraphs, other devices may be required for functions such as those listed below:

- Regular and Backup relay schemes
- Carrier and/or transfer trip equipment
- Automatic checkback for the communication equipment
- Breaker failure relaying
- Close into fault relaying

4.12.5 Additional Relay Requirements for Generators Connected to 4 kV or 13 kV Overhead Circuits

The installation of any generation capable of supplying any level of fault current for a fault on the 4 kV or 13 kV PSE&G system must meet all of the requirements of the IEEE 1547 standard (as indicated in Section 3.7) and must also meet the additional requirements noted below. These requirements are in place to ensure PSE&G line worker safety. PSE&G line workers maintain wire and equipment on 4 kV and 13 kV distribution circuits while energized and, therefore, any fault that might occur while they are working **must** be cleared instantaneously. The customer will be required to perform the tasks noted below to demonstrate that the protection system for their generator will properly clear a fault on the PSE&G system with no intentional time delay. There are many ways this can be accomplished, and the method must be approved by the PSE&G System Protection group.

At a minimum, the following tasks must be completed prior to approval.

1. The customer must perform a simplified short circuit study that, at a minimum, will indicate the following:
   a. Generator supplied fault current for a three-phase fault and for a phase to ground fault on the PSE&G system (4 kV or 13 kV). The PSE&G transformer configuration must be taken into account when performing this study.
   b. Generator supplied voltages and speed of voltage decay following the fault after the loss of utility supply.
2. The customer must indicate the relay element(s) that will trip instantaneously for the events modeled above. This may be a directional overcurrent element, an undervoltage element, an instantaneous minimum power import element, or another protection function. There must be no intentional time delay for the clearing of this event. Please note that these protection constraints may result in “nuisance trips” due to disturbances on the PSE&G system throughout the life of the installation.

   Additionally, if the customer is fed from a PSE&G transformer that is DELTA connected on the primary (13kV or 4kV) side, the customer must determine how the generator is going to clear ground faults on the PSE&G system (since the DELTA connection will not allow ground fault current to flow), and gain approval from the PSE&G system protection group.
3. The customer must certify that:
   a. They fully understand the worker safety issue described above.
   b. Generator protection designed to trip with no intentional time delay for a fault on the PSE&G system has been provided and will never be removed from service while the generator is running.

4.13 Acceptable Relays

All Non-Utility Generator interconnection protection relays used to satisfy the above requirements, or any additional PSE&G requirements, or any relays that trip breakers that may affect PSE&G load flow must come from the PSE&G list of acceptable microprocessor relays. Contact PSE&G System Protection Department for the latest version of this list

Interconnection relay settings shall be set based on IEEE Standard 1547-2003 (R2008) “Standard for Interconnecting Distributed Resources with Electric Power Systems” with the Amendment IEEE Std 1547a™-2014 and any subsequent subparts of IEEE 1547. PSE&G may provide additional relay requirements superseding the ones from above-mentioned IEEE Standards

The relay AC inputs and DC outputs are to be isolated by ABB FT-1 test switches.

Note

1. When relays are required for the protection of a sub-transmission line or a transmission line, requirements covering those applications are very specific and are based on the voltage class, line configuration, etc. Such requirements are not in the scope of this document. The PSE&G System Protection Group in Newark must be contacted for specific recommendations. At that time, sample AC and DC schematics will be provided by PSE&G.
2. For other applications (i.e. bus differential protection) the same System Protection Group in Newark must be contacted for specific recommendations.

4.14 Inspection and Maintenance

Periodic inspection and maintenance of the equipment and facilities is necessary to assure proper operation and function. PSE&G shall be granted access for its authorized representatives during any reasonable hours to install, check and maintain it's metering equipment and/or for operation of the interconnection disconnecting device.

Types of maintenance that a NUG would be responsible for at its facility consist of diagnostic testing and sampling, minor maintenance items and major maintenance items, for example:

- Diagnostic testing and sampling

  Is performed either on in-service equipment or on equipment out of service but immediately available for service. Examples might be obtaining oil samples for gas-in-oil analysis and thermovision heat detection scanning.

- Minor maintenance

  Would require the equipment to be out of service but available for return to service within a few hours or less. Examples might be lubrication of mechanisms, checking the proper operation of pressure switches; checking the operation and synchronism of disconnect switches, meggering, ductoring, timing checks, interrupting medium moisture tests as well as relay setting checks and operational function tests.

- Major maintenance

  Would include the complete or partial disassembly of a piece of equipment, and would usually involve taking an extended outage. Examples would be the replacement of contacts in a tap changing mechanism, or the replacement of a transformer bushing.

Schedules for maintenance should be developed based on equipment manufacturer's suggestions, the operating record, inspection results, past maintenance experience, the critical nature of the equipment and the shut-down schedule of the facility. Maintenance may be performed by the customer's own personnel, or a qualified contractor.

As part of the interconnection agreement, specific equipment will be identified and maintained by PSE&G (at the NUG's expense). The requirements for this type of maintenance are established by the need to maintain the integrity of the PSE&G System and prevent interference to other NUGs or customers. This maintenance must not be duplicated by the customer or their contractor. Coordination and communication between PSE&G and those doing the maintenance for the customer should be initiated.

5. Revenue Metering

PSE&G shall install, own, operate and maintain the electric revenue meter(s) at the NUG facility, in order to accurately measure the quantity of electricity received from the NUG facility.

PSE&G shall designate, select, specify, own, operate and maintain all associated revenue metering equipment required to provide the metering data showing how much electricity the NUG supplies to or receives from the PSE&G System. All metering expenses will be paid by the NUG.

5.1 Documentation

The applicant must submit the following documentation:

- Electrical one-line detailing disconnect, metering and relay locations.
- Conduit drawing if applicable.
- Detailed switch-gear diagrams showing the location of CTs and potential transformers (**PTs**), metering and relays (if applicable).
- Detailed compartment diagrams showing the dimensions of each compartment where PSE&G equipment will reside.
- Test results from meggering the bus and ground grid resistance.
- Ground grid details.
- Telecommunication details.

5.2 Instrument Transformers

PSE&G will supply CTs, PTs and the control wire to the meter. The applicant will be responsible for the installation of that equipment. Refer to Section 7. for the appropriate specifications that are specific to your project's voltage requirements.

5.3 Revenue Metering Cabinet

The applicant will be responsible to install the metering cabinet. This cabinet will consist of a simple meter socket, a Hoffman-Type Box or a Schweitzer Enclosure. The applicant will provide and install the meter socket or Hoffman Box. PSE&G will provide the Schweitzer enclosure at the customer's expense which will be installed by the applicant. PSE&G will designate which type will be required.

5.4 Telemetering and Supervisory Control and Data Acquisition (SCADA)

For telemetering and SCADA requirements see Section 4.9.1 and Section 4.9.2. In case Schweitzer enclosure is used as a revenue metering cabinet, it may house telemetering and SCADA equipment as well. For layouts of typical Schweitzer enclosures, see Figure 7.2 and Figure 7.3.

5.5 Process where an existing Net Metering Customer no longer qualifies.

In cases where a net metering customer goes out of business, the generator output no longer qualifies for net metering since the load will most likely far exceed the customer's use. In this scenario, the customer no longer qualifies for net metering reimbursement for excess generation. If the owner of the panels wishes to sell the output to PSE&G, they must obtain Qualifying Facility status and can then sell the output through the PEP Tariff. This may involve modifications to the customer's metering and any expenses incurred would be borne by the customer.

Figure 7.2: Typical Schweitzer Metering/SCADA Enclosure for 480 V through 13 kV NUG Connections

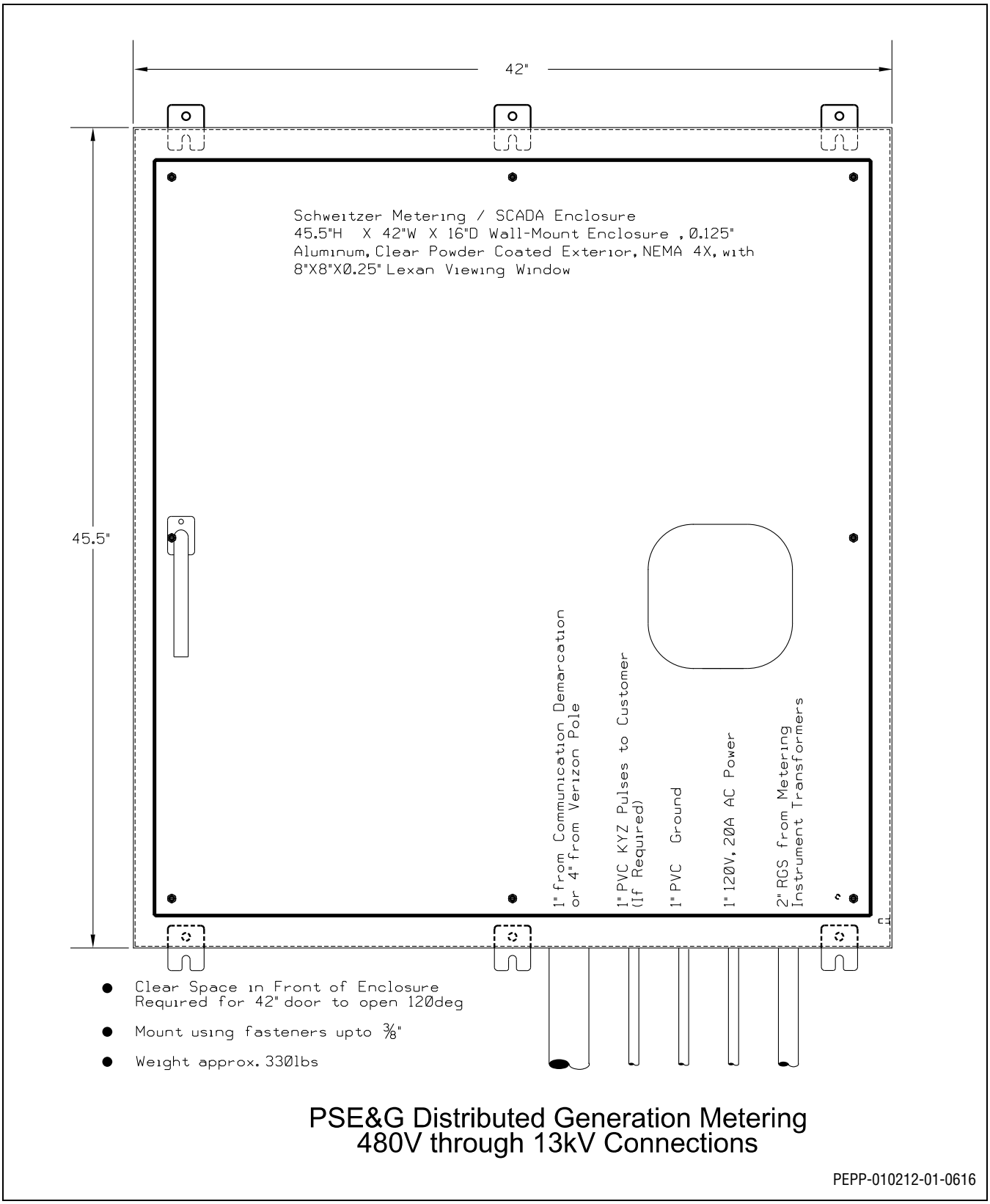
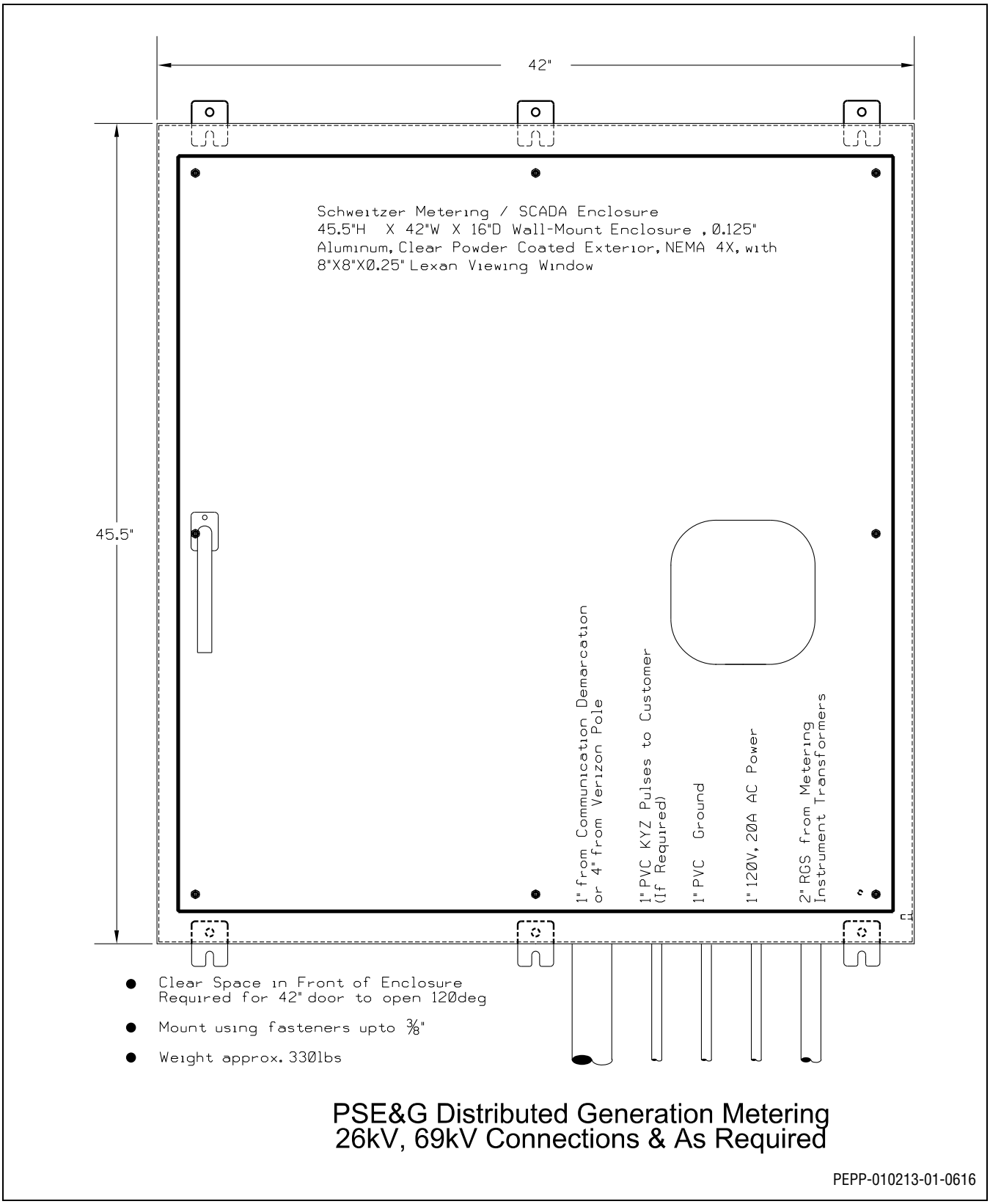


Figure 7.3: Typical Schweitzer Metering/SCADA Enclosure for 26 kV, 69 kV NUG Connections and as Required



6. Network Service

Installing NUGs in areas served by secondary or spot networks is complicated by the manner in which such networks operate. The PSE&G transformers that supply power to a secondary network are protected against backfeed by a device called a network protector. When the transformer is energized from the secondary, the network protector will trip the transformer secondary breaker upon backfeed with minimal time delay. An excessive number of operations of the protector will lead to its premature failure.

6.1 Network Basics

Networks are special distribution systems that utilize two or more primary voltage feeders (either 26 kV, 13 kV or 4 kV) that are essentially connected in parallel. In a typical network, each feeder is connected to a special step-down transformer called a Network Transformer. The Network Transformer is a submersible device that is placed in an underground vault and transforms the primary voltage to the service voltage, either 120/208 VAC three phase or 277/480 VAC three phase. Attached to each Network transformer is a device called a Network Protector. The Network Protector is a high capacity submersible circuit breaker. A Network Protector is controlled and protected by a microprocessor device called a Network Protector Relay. The Network Protector Relay is physically installed inside of the Network Protector. The output terminals of the Network Transformer/Protector are connected in parallel with one or more other Network Transformer/ Protectors. A two-circuit network may have two Network Transformer/Protectors connected in parallel. A three-circuit network may have three Network Transformer/Protectors connected in parallel and so on. The point where all of the Network Transformer/Protectors are connected together is called the Network Bus. One or more services are connected and fed from this Network Bus.

6.2 Types of Networks

There are two basic types of network design available:

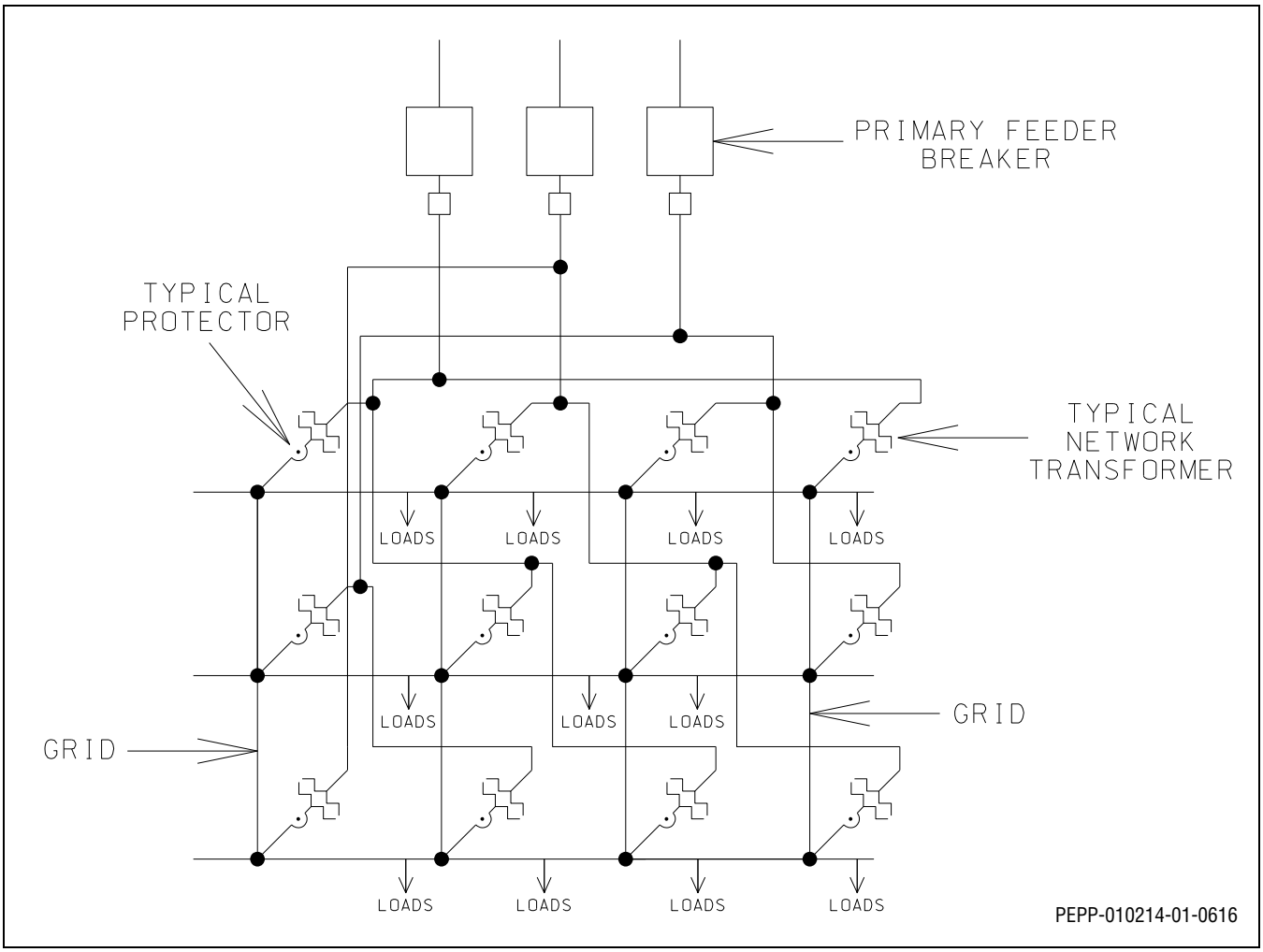
1. Spot Network

   The Spot Network is typically used to feed a large building in an urban area, where all of the Network Transformer/Protectors and the Network Bus are located in a vault in front of the large building. The Spot Network will only feed this one large facility.

2. Area Network

   An Area Network is used to serve multiple smaller buildings and typically uses a distributed Network Bus. In an Area Network the Network Transformer/Protectors are not placed in a common vault but are located in two or more vaults spread around the network area. The Network Transformer/Protectors are connected together at the secondary voltage level via a cable bus. The individual customers are connected to this cable bus. The area network can be as large as depicted in Figure 7.4, where it is shown with three rungs or as small as a single rung. Larger networks are more capable of absorbing the output of distributed generators, within reason.

Figure 7.4: Area Network



6.3 Network Interconnection Issues

Networks are designed to restrict backfeed to the utility source. In a NUG installation on a network system, the entire output of the generator must be absorbed by the load attached to the Network Bus. If the generator output exceeds the load at the facility, the excess power will begin to backfeed which will cause the network protectors to open. At this point the customer will lose power.

The Network Protector and its Protective Relay are designed to detect and act on two types of backfeed. First, “high level” backfeed in a network occurs if there is a phase-to-phase or three-phase fault on any of the primary voltage network feeders. If a phase-to-phase or three-phase fault occurs on a primary voltage feeder, the Network Transformer/Protector detects the fault and immediately opens preventing the unfaulted feeders from backfeeding through the Network Bus. This protective action occurs almost immediately with no interruption to the customer.

Secondly, “low level” backfeed will occur if the source feeder becomes de-energized (most commonly caused by a ground fault on a source cable resulting in the opening of the utility station breaker). The Network Transformer/Protector will open after a time delay.

In the case of a NUG installation, if the generator output meets or exceeds the load connected to, then the Network Transformer/Protector will trip due to low level backfeed.

Exported power looks like backfeed current to the Network Protection Relay. All Network Protectors connected to the common low voltage bus will see reverse current and will open, causing the facility to lose power.

6.4 NUG – Any Power Output Level – Export

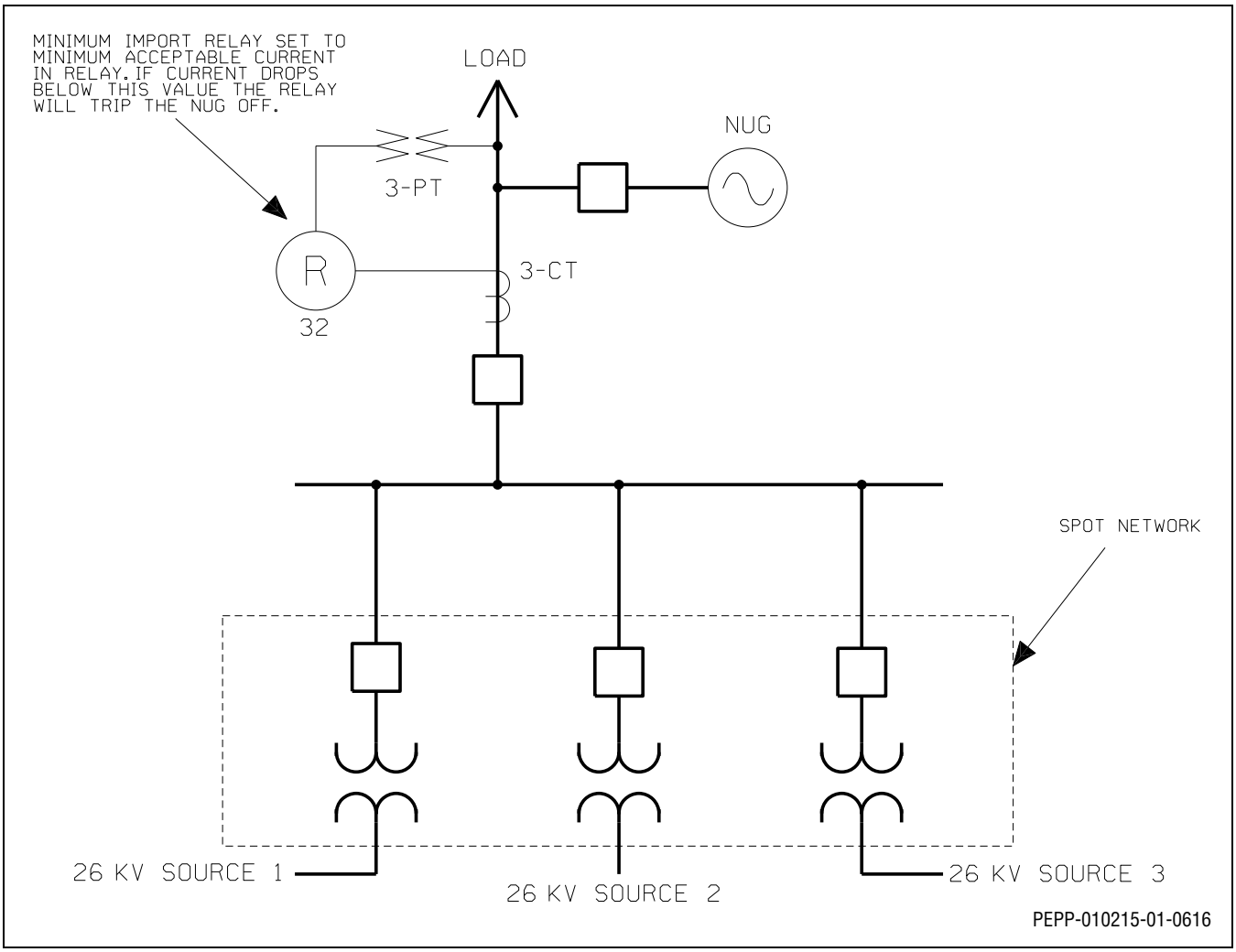
Since the network protectors will operate to trip the transformer secondary breaker without delay whenever back-feeding occurs, it is typically not possible to install an exporting NUG in a secondary network. Spot networks that do not utilize network protectors, depending upon their configuration and service characteristics, may permit export in certain circumstances.

6.5 Rotating NUG – Any Power Output Level Not Utilizing Class 1 Renewable Fuels – Non-Export

For NUGs who do not intend to export power to the grid, installation in a network area is possible. PSE&G must perform a Feasibility and/or Impact Study on the effect of adding such generation to the network, and such studies shall be performed at the cost of the NUG. Such studies will investigate the electrical loading of the network, the devices currently installed in the network, and the effects of adding such a NUG facility to the network. Upon completion of the Impact Study, the NUG will be given an office estimate of the cost of interconnecting the NUG into the network, assuming that it is possible to do so. If the NUG wishes to proceed, a Facility Study must be performed at the NUG's expense, which will develop detailed estimates for interconnection costs and a schedule for the work.

The relay protection design for the NUG will require that it install a minimum import relay with a directional power function (32) at the point of interconnection with PSE&G (see Figure 7.5). Sufficient power must flow into the NUG such that enough current is detected by the CTs that the 32 element can operate. If power flow into the NUG is not maintained, the 32 element will open a breaker between the generator and PSE&G. This method of always importing a small amount of power is required to ensure proper operation of the directional power element, since whenever the 32 element detects any power flow from the NUG into the PSE&G System, the 32 element will isolate the generator from PSE&G. The relay with a directional power function (32) shall be fed by three single-phase CT and three single-phase PT located on the customer side of the service entrance breaker. The PT shall be connected wye-wye.

Figure 7.5: Scheme with a Minimum Import Relay



In order to limit unnecessary operations during faults on the PSE&G System or loss of load in the NUG's facility, the directional power element should be set with an operating time delay less than 0.5 seconds. In addition, any network protectors that supply the network may need to be modified by PSE&G to accept time-delay relays. The cost of this modification is the responsibility of the NUG.

All this protective system should be designed, set and tested by the customer. It is the customer's responsibility to go through the proper channels to find the network service details for proper design including the service type, and network voltages. The relay shall be wired to trip the generator upon relay failure and loss of relay control power.

Upon request, PSE&G will provide recommendations for the relay type, wiring etc. However, under no circumstances shall PSE&G assume responsibility for design flaws, setting errors or other deficiencies in the system that might result in undesired trips or equipment damage. Any damage to PSE&G equipment caused by deficient design, erroneous relay settings (even if reviewed by PSE&G) or any other failure to meet the requirements herein shall be the sole responsibility of the customer.

In case a network includes 4 kV or 13 kV circuits, relay protection requirements listed above should be superseded by requirements explained in Section 4.12.5.

6.6 Rotating Non-Utility Generators utilizing Class 1 renewable fuels

As mentioned in Section 3.2 above, all current rules for interconnecting NUGs using Class 1 renewable fuels with a local electric distribution company in New Jersey is described in the N.J.A.C. Subchapter 5 – "Interconnection of Class 1 Renewable Energy Systems" Sections 14:8-5.1 through 14:8-5.9.

§ 14:8-5.5 Level 2 interconnection review is covering applications to connect customer-generator facilities with a power rating of two MW or less, which meet the certification requirements at N.J.A.C. 14:8-5.3. While Sections 14:8-5.5 (c) through (k) describe requirements for any interconnection with a local electric company's distribution systems, if a rotating NUG has a proposed point of common coupling with EDC on a spot or area network, the interconnection shall meet the following additional requirements described in Section 14:8-5.5 (l) 1 and 3:

1. For a customer-generator facility that will be connected to a spot network circuit, the aggregate generation capacity connected to that spot network from customer-generator facilities, including the customer-generator facility, shall not exceed 5% of the spot network's maximum load;
2. For a customer-generator facility that will be connected to a spot or an area network that does not utilize inverter based protective functions … the customer-generator facility shall utilize reverse power relays or other protection devices that ensure no export of power from the customer-generator facility, including inadvertent export (under fault conditions) that could adversely affect protective devices on the network.

If application to interconnect a customer-generator facility to the Network does not qualify for Level 2 interconnection review procedures set forth at N.J.A.C. 14:8-5.5, then the Developer may apply for a Level 3 interconnection review described in the N.J.A.C. Section 14:8-5.6 which will require at the customers expense to conduct the impact study of the probable impact of a customer-generator facility on the safety and reliability of the EDC's electric distribution system as well as a load study to determine the minimum load of the network.

To fulfill requirement stated in N.J.A.C. 14:8-5.5., (l) 3 (see above) PSE&G requires the use of a minimum import/reverse power relay, described in Section 6.3 (see Figure 7.5) under all previously mentioned conditions.

7. Additional Resources

1. PSE&G Information and Requirements
   http://www.pseg.com/business/builders/new_service/before/pdf/RequirementsElecSvc2005.pdf
2. Chapter 3 – Customer Requirements for Primary Service
   http://www.pseg.com/business/builders/new_service/before/pdf/pepp/sec03.pdf
3. Chapter 4 – General Specifications for a Customer-Owned 26.4 kV Substation
   http://www.pseg.com/business/builders/new_service/before/pdf/pepp/sec04.pdf
4. Chapter 5 – General Specifications for a Customer-Owned 26.4 kV Metal-Clad Substation
   http://www.pseg.com/business/builders/new_service/before/pdf/pepp/sec05.pdf
5. Chapter 6 – General Specifications for 69KV Outdoor Substations
   http://www.pseg.com/business/builders/new_service/before/pdf/pepp/sec06.pdf

6. Chapter 11 – General Specifications for Inverter-Based Non-Utility Generators (NUGs)
   http://www.pseg.com/business/builders/new_service/before/pdf/pepp/sec11.pdf
7. Technical Support Contact
   Michael.Henry@PSEG.com