ACTION FORM

PROCEEDING: Utility Committee	**AGENDA ITEM NO.:** 11/13/06 – 1A
DEPARTMENT OF ORIGIN: Public Utilities - Electric	**DATE SUBMITTED**: 10-26-06
PREPARED BY: Stephen A. Enss	
SUBJECT: Green Energy Program – Net Metering Tariff	
REFERENCE: N/A	
RELATED PROJECT: N/A	
APPROVALS: City Manager	
EXHIBITS: Net Energy Metering Tariff	
EXPENDITURE REQUIRED: N/A	**AMOUNT BUDGETED**: N/A
FUNDING SOURCE (Dept./Page in CIP & Budget): N/A	
TIMETABLE: Program is mandated to begin January 1, 2007	
RECOMMENDED ACTION: Staff recommends accepting the new Net Metering Tariff (attached) to be effective January 1, 2007	

BACKGROUND AND ANALYSIS

In the summer of 2005, the State of Delaware issued a Renewable Energy Portfolio Standard (Delaware Code, Title 26, Chapter 1, Sections 351-363). Section 363 - Special provisions for municipal electric companies and rural electric cooperatives reads as follows:

Municipal electric companies and rural electric cooperatives may elect to be exempt from the requirements of this subchapter provided that, on or before June 1, 2006, they:

(1) Submit a written notice to the General Assembly;
(2) Alert their end-use customers with notices inserted in 2 consecutive electricity bills;
(3) Offer their retail customers a voluntary program for purchasing renewable energy under competitive rates; and
(4) Either contribute to the Green Energy Fund at levels commensurate with other retail electricity suppliers or create an independent, self-administered fund separate from the Green Energy Fund to be used in support of energy efficiency technologies, renewable energy technologies, or demand side management programs, into which they make payments of $0.178 for each megawatt-hour they sell, transmit, or distribute in the State. (75 Del. Laws, c. 205, § 1.)

The City of Dover has followed the four steps to be completed and has generated a new electrical tariff to meet the requirements effective January 1, 2007. To fulfill Section (4) the City must have a Net Metering electric tariff for Green Energy projects that will sell power back into the electric system. Without this tariff, the City cannot support this technology as required in Section (4).

The attached tariff will allow the City to credit the customer for KWH delivered from the customer to the City of Dover. The rate of credit will be reviewed and adjusted annually. This will only be allowed for residential, small and medium commercial customers with less than 50KW of generation. All other rate classes or projects generating more than 50KW will be handled through special contracts.

Net Energy Metering
"NM"

AVAILABILITY

This rider is available to customers served under the following service classifications, Residential "R", Small Commercial "C and C1", and Medium Commercial "C2 and C3" who own and operate an electric generation facility on the Customer's premises. The primary intent of this installation is to offset part or all of the Customer's electricity requirements. Capacity cannot be more than 50 kilowatts. The primary source of fuel must be solar, wind, hydro, or another approved source of renewable energy. This rider is applicable to generation interconnected and operated in parallel with the City of Dover's transmission and/or distribution facilities. Application for the installation of any generation system in excess of 50 kilowatts shall be made under a special contract.

Any customer who elects this rider must apply by filling out the Generator Interconnection Application at least 60 days in advance of the proposed activation date. Approval of the application by the City must be granted prior to activation the electric generation facility.

CONNECTION TO THE CITY'S SYSTEM

The electric generation system cannot be connected to the City's system unless it meets all applicable safety and performance standards set forth by the following: The Technical Considerations Covering Parallel Operations of Customer Owned Generation of 50 kW or Less dated January 1, 2007, National Electric Safety Code, Underwriters Laboratories, and the City of Dover Electric Service Handbook. The Customer must, at his/her expense, obtain any and all necessary permits, inspections, and approvals required by any local public authorities and any other governing regulations in effect at that time.

DELIVERED VOLTAGE

The delivered voltage and delivery point of the Customer's electric generation shall be at the same delivered voltage and delivery point that would be supplied by the City if the Customer purchased all of it's electricity from the City.

CONTRACT TERM

The contract term shall be the same as the Customer's applicable rate tariff.

RATE

The monthly billing shall be as stated in the applicable rate tariff. Under this rider, only the per kWh charge for electricity delivered by the Customer is affected. The Customer will pay for all kWh delivered by the City of Dover. If the Customer has delivered electricity to the City system, a credit will be issued to the Customer for the kWh delivered at the City's current wholesale rate.

POWER FACTOR PENALTY

A power factor penalty may be assessed, at the City's option, on any customer being served on this tariff. The penalty will be calculated using the following formula:

The Measured Demand will be the maximum fifteen (15) minute demand during the billing cycle. In any month in which the average power factor at the delivery point is less than ninety-five percent (95%) the penalty will be calculated according to the following formula:

$$\text{Power Factor Corrected Demand} = \frac{\text{Measured Demand X .95}}{\text{Average Power Factor}}$$

The difference between the Power Factor Corrected Demand and the Measured Demand is the kW penalty that will be assessed. This kW will be billed at the current Demand Rate on the C2/C3 Rate Tariff. There will be no credits issued for power factors that exceed ninety-five percent (95%).

METERING

A bi-directional watt-hour electric meter will be installed at the Customer's location to measure the energy consumed and the energy delivered to the City system.. The City will furnish, install, maintain, and own all metering equipment. Cost will be determined under the Additional Costs and Responsibilities clause below.

ADDITIONAL COSTS AND RESPONSIBILITIES

The Customer will be required to pay for any additional transmission and distribution costs, the cost of metering, transformation, system protection, and any related safety/protective equipment in excess of what would normally be paid for by the City. Protective equipment will be installed by the Customer to provide safety for personnel, provide adequate protection for the City's electric utility system and to the Customer's property, and to prevent any interference with the City's supply of energy to other utility customers. This equipment will be owned, installed, and maintained by the Customer.

FAILURE TO COMPLY

The City may disconnect the Customers service from the City's electric system if the Customer fails to comply with any of the stipulations of this rider, The Technical Considerations Covering Parallel Operations of Customer Owned Generation of 50 kW or Less dated January 1, 2007, National Electric Safety Code, Underwriters Laboratories, the Generator Interconnection Application and the City of Dover Electric Service Handbook.

RULES AND REGULATIONS

The General Rules and Regulations of the City of Dover for electric service shall apply to service rendered under this service classification. All minimum billings, charges for kWh, kW, Purchased Power Adjustment, Public Utility Tax, Renewal Energy Charge, etc. will be covered under the applicable rate tariff.

ACTION FORM

PROCEEDING: Utility Committee	**AGENDA ITEM NO.:** 11/13/06 – 1B
DEPARTMENT OF ORIGIN: Public Utilities - Electric	**DATE SUBMITTED**: 10-26-06
PREPARED BY: Stephen A. Enss	
SUBJECT: Green Energy Program – Technical Considerations	
REFERENCE: Electric Service Handbook	
RELATED PROJECT: Net Metering	
APPROVALS: City Manager	
EXHIBITS: Technical Considerations Covering Parallel Operations of Customer Owned Generation	
EXPENDITURE REQUIRED: N/A **AMOUNT BUDGETED**: N/A **FUNDING SOURCE (Dept./Page in CIP & Budget)**: N/A	
TIMETABLE: Upon Council approval, amend the Electric Service Handbook	
RECOMMENDED ACTION: Staff recommends accepting additional language (Technical Consideration Covering Parallel Operations of Customer Owned Generation) to the Electric Service Handbook.	

BACKGROUND AND ANALYSIS

In the summer of 2005, the State of Delaware issued a Rnewable Energy Portfolio Standard (Delaware Code, Title 26, Chapter 1, Sections 351-363). *Section 363 - Special provisions for municipal electric companies and rural electric cooperatives* with which the City of Dover is required to comply. To comply with this law which requires the City to support Green Energy Technology such as solar and wind power projects, technical guidelines for installation of these technologies must be adopted.

To insure a safe and proper operation of customer owned generation and the City's electric infrastructure, technical guidelines have been created. The attached technical considerations are being recommended for inclusion in the City of Dover's Electric Service Handbook as Division VI – Parallel Operations of Customer Owned Generation.

City of Dover

Technical Considerations Covering Parallel Operations of Customer Owned Generation

Of

50 Kilowatts or Less

And

Interconnected with the City of Dover System

January 1, 2007

Technical Considerations Covering Parallel Operations Of Customer Owned Generation of 50 Kilowatts or less and Interconnected with the City of Dover Delivery System

Perquisite – The customer must first be in compliance with the tariff rules and regulations and the applicable tariff classification and rates. The terms and conditions contained herein are in addition to, but do not modify nor negate, the terms of the tariff.

I Purpose – The purpose of this document (relating to interconnection of on-site distributed generation and parallel generation requirements) is to clearly state the terms and conditions that govern the interconnection and parallel operation of on-site distributed generation, in order to:

A. establish technical requirements which will promote the safe and reliable parallel operation of distributed generation resources;
B. enhance the reliability of electric service;
C. facilitate the implementation and use of distributed resources technologies;
D. enhance economic efficiency in the production and consumption of electricity and other energy; and
E. promote the use of distributed resources in order to provide electric system benefits during periods of capacity constraint.

II Applicability - Unless otherwise provided, these guidelines apply to all customer generation operating below 51 kilowatts which is interconnected at 34.5kV or below and operated in parallel with the Company's power delivery System. The technical requirements of Section XIV and subsequent sections of this document do not apply to NEM Rider Tariff generators using inverter technology, as requirements for these installations are already covered in the applicable codes, IEEE Standard 929, *Recommended Practice for Utility Interface of Photovoltaic (PV) Systems, and UL 1741, Underwriters Laboratories Subject 1741-1999, Standards for Static Inverters and Charge Controllers for use in Photovoltaic Power Systems.*

III Definitions

A. Account - An account is one metered or un-metered rate or service classification which normally has one electric delivery point of service. Each account shall have only one electric service supplier providing full electric supply requirements for that account. A premises may have more than one account.

B. Company – City of Dover

C. Customer – Any adult person, partnership, association, corporation, or other entity: (i) in whose name a service account is listed, (ii) who occupies or is the ratepayer for a premises, building, structure, etc., and (iii) who is primarily responsible for payment of bills. A customer includes anyone taking Delivery Service or combined Electric Supply & Delivery Service from the Company under one service classification for one account, premises or site. Multiple premises or sites under the same name are considered multiple Customers.

D. Distributed Generation or On-Site Distributed Generation - an electrical generating unit of less than or equal to 50 kW which may be connected in parallel operation to the Company's system.

E. Generator Owner - the owner of the generating system that is interconnected to the Company.

F. **Grid -** The interconnected arrangement of lines and transformers that make up the Company's electric power system.

G. **IEEE Standard 929 -** IEEE Standard entitled *Recommended Practice for Utility Interface of Photovoltaic (PV) Systems*, P929 Draft 11, dated July, 1999, or subsequent approved revision thereof.

H. **Interconnection –** the physical connection of distributed generation to the Company's system in accordance with these guidelines so that parallel operation can occur.

I. **Interconnection Application -** the standard form of application which must be submitted by the Generation Owner to the Company for permission to interconnect with the Company system. The approved Interconnection Application sets forth the contractual conditions under which the Company and Generator Owner agree that one or more generating units whose aggregate generation at the Point of Common Coupling is less than or equal to 50 kW may be interconnected at 34.5 kV or less with the Company's system.

J. **Inverter –** A static power converter with control, protection and filtering functions that converts Direct Current input to Alternating Current output. Inverters must be of the non-islanding type.

K. **Island -** A portion of the utility system which contains both load and distributed generation and is isolated from the remainder of the utility system.

L. **Parallel Operation -** any electrical connection between the Company's system and the Generator Owner's generating source.

M. **Point of Common Coupling -** the point where the electrical conductors of the Company system are connected to the Customer's conductors and where any transfer of electric power between the Generator Owner and the Company System takes place (such as switchgear near the meter).

N. **Pre-Approved Equipment -** specific generating and protective equipment system or systems that have been approved by the Company as meeting the applicable parts of this document.

O. **Pre-Interconnection Study -** a study or studies which may be undertaken by the Company in response to its receipt of a completed application for parallel operation with the Company's system submitted on the Interconnected Application form prescribed by these guidelines. Pre-Interconnection Studies may include, but are not limited to service studies, coordination studies and facilities impact studies.

P. **Qualifying Facility (QF) -** an electric generation facility which is a qualifying facility under Subpart B, Section 201 of the Federal Energy Regulatory Commission's regulations per the Public Utility Regulatory Policies Act of 1978.

Q. **Stabilized -** the Company's system following a disturbance which returns to the normal range of voltage and frequency for at least 5 minutes or longer as coordinated with the Company. The Company may require a longer period upon a reasonable showing that the reconnection after 5 minutes will adversely affect the safety and reliability of the electric system.

R. **Unit –** a distributed generation facility.

S. **Utility System or Electric Distribution Facility -** Company's distribution system operating at 34.5 kilovolts or below to which the generation equipment is interconnected.

IV Interconnection Application - A proposed Generator Owner will make a formal application to the Company for the interconnection of a generator to the Company system. The application will be made on an Application Form provided by the Company.

V. Designation of Company Contact Persons for Matters Relating to Distributed Generation Interconnection – The Company's Electric Engineering Department will be the designated point of contact for all matters related to interconnected generation. The Company will maintain records concerning applications received for interconnection and parallel operation of distributed generation. Such records will include the date of receipt of each such application, documents generated in the course of processing such applications, correspondence regarding such applications and the final disposition of such application.

VI. Pre-Interconnection Studies – In many instances the Company will wish to conduct a service study, coordination study, or facilities impact study prior to interconnection of a distributed generation unit. In instances where such studies are deemed necessary the scope of such studies shall be based on the characteristics of the particular distributed generation unit to be interconnected and the proposed point of interconnection.

A) Completion of Pre-interconnection Study - Upon completion of the interconnection study, the Company will notify the Generator Owner that his application has been approved or indicate insufficient detail why the application cannot be approved. The conducting of such pre-interconnection studies shall not unduly delay the interconnection of the distributed generation. In no event shall such studies take longer to complete than 4 weeks after receipt of signed customer application and customer submittal of all required data.

B) Pre-interconnection Study Fee - The Company will do a pre-interconnection study without charge up to the typical and customary cost that the Company would expend for study work of similar type of customer interconnection. If the cost to the Company is expected to exceed this typical and customary amount, or if multiple submittals by the Generator Owner are necessary, the Company will advise the Generator Owner of the expected cost of such study work by the Company before such work begins. The Generator Owner will be responsible for payment of all costs above the typical and customary amount.

VII Network Interconnection of Distributed Generation – Where generation is to be connected to a network system and capable of exporting power to the Grid, the interconnection study may result in more stringent interconnection requirements.

VIII Pre-approval of Generation units, Devices and Systems - Upon approval by the Company that certain generating unit's protective devices and/or system(s) meet the standards set out in these guidelines, such approval shall be made available to the appropriate manufacturer upon written request. For subsequent applications using some or all of the identical generating unit's protective devices and/or systems, the manufacturer may submit a copy of the approval with the application as proof that its equipment has already been approved for use on the Company's system. Use of pre-approved equipment will not eliminate any applicable requirement for a pre-interconnection study to determine the suitability of the equipment for each application, given the unique arrangements and characteristics of both the Generator Owner and Company systems at the point of the interconnection.

IX Connection Approval – The Generator Owner can connect their generation to the Company system only after the Interconnection Application has been approved and the Generation Owner has received approval notification. The Company will provide notification within four weeks after the receipt of the Interconnection Application and all required data.

X Interconnected Generation Site Warning Label – The Generator Owner will install a warning label in a conspicuous place on their electric meter or meter box to notify the Company personnel that there is a generator source installed on the load side of the meter. The warning label shall not be placed in a location that would interfere with the ability of Company personnel to read the electric meter. The Company will provide the warning label to the Generator Owner. The warning label must be placed before the generation can be interconnected.

XI Disconnection and Reconnection.

The Company may disconnect a distributed generation unit under the following conditions:

1) Application Termination – Upon termination of the approved Interconnection Application.

2) Non Compliance – For non-compliance with the technical guidelines specified in this document or other requirements contained in the applicable Customer Tariff, provided that the Company has given notice to the Generator Owner and provided the Generator Owner reasonable time (consistent with the condition) to correct such non-compliance. The Company will reconnect the unit only upon receipt of certification from the Generator Owner and verification by the Company that the unit is in compliance. The Company will provide verification within a reasonable time period.

3) In Case of a system emergency outage of the Company's Primary Electrical Sources – The Generator Owner's generation equipment must be installed and configured so that parallel operation must automatically cease immediately and automatically during outages or loss of the Company's electric source in accordinacnce with these guidelines. The Generation Owner must also cease parallel operation upon notification by the Company of a system emergency, abnormal condition or in cases where such operation is determined to be unsafe, interferes with the supply of service to other customers or interferes with the Company's system maintenance or operation. In addition, the Company may disconnect the generator from the system for system emergencies without notice. However, the Company will use reasonable efforts to notify the Generation Owner prior to disconnecting.

4) For Routine Maintenance and Repairs – The Company may disconnect a Customer/Generation Owner for routine maintenance and repairs on the Company's system consistent with applicable tariffs and agreements. The Company will make reasonable efforts to provide advance notice to the Customer/Generation Owner of service interruptions resulting from routine maintenance.

The Company will reconnect the Customer/Generation Owner as quickly as possible under reasonable operations constraints following any such service interruption.

XII Termination – The Generation Owner may terminate the approved Interconnection Application at any time upon thirty (30) days of providing written notice to the Company. The Company may terminate the Interconnection Application for cause after 60 days written notice to the Generator Owner of a material violation of the terms of the approved Interconnection Application and after the Generator Owner has had a reasonable opportunity to remedy the violation. The Generator Owner must give the Company notice that it intents to permanently shut down his generation.

XIII Privileged Communications Concerning Proposed Distributed Generation Projects – In the course of processing applications for parallel operation and in the conduct of pre-interconnection studies, the Generation Owner shall provide the Company with detailed information concerning the proposed distributed generation project. The Company shall not use such knowledge of proposed distributed generator projects submitted to it for review to prepare competing proposals to the Generator Owner

whereby the Company, or its affiliate, offers either discounted rates in return for not installing the distributed generation, or offers competing distributed generation projects.

XIV **Technical Guidelines for Parallel Operation of On-site Distributed Generation Units** – This subsection describes minimum requirements and procedures for safe and effective connection and operation of distributed generation. A Generator Owner may operate 60 Hertz, three phase or single phase generating equipment, whether a QF or non-QF, in parallel with the Company's system pursuant to an approved Interconnection Application provided that the equipment and Generator Owner meet or exceed the requirements of these guidelines or the NEM Rider Tariff requirements and that the Company has approved the Generator Owner's application to interconnect. This subsection describes typical interconnection requirements. Certain specific interconnection locations and conditions may require the installation of additional protective hardware or special protection settings, especially when exporting power to the system. If the Company excludes that an application for parallel operation requires additional protective hardware or special protection settings, the Company shall make those requirements known to the Generator Owner within 14 days after all pertinent studies are completed.

Approval to connect to the Company system indicates only that the minimum requirements for a safe proper interconnection have been satisfied. Such approval does not imply that the Generator Owner's facility meets all federal, state and local standards or regulations.

A) General Interconnection and Protection Requirements.

1) The Generator Owner's generation and interconnection installation must meet all applicable national, state, and local construction and safety codes.

2) The Generator Owner's generator shall be equipped with protective hardware and software designed to prevent the generator from energizing one of the Company's de-energized circuits. The Generator Owner's generator must automatically disconnect from the Company's system if the Grid source is lost, irrespectively of connect loads or other generators.

3) The generator shall be equipped with the necessary protective hardware and software designed to prevent sustained parallel operation of the generating equipment with the Company's system unless the system service voltage and frequency are within acceptable magnitudes as defined in Section XIV.B.

4) Pre-approved equipment shall be accepted as part of an interconnection proposal without the need to re-review the equipment itself. However, the application, design and setting of pre-approved units and/or equipment must be reviewed and coordinated according to the unique needs of the specific location of the proposed installation. Where a complete unit or system has been pre-approved, only location-specific issues will typically need to be reviewed.

5) The Generator Owner will be responsible for protecting its own generating and interconnection equipment in such a manner so that Company system outages, short circuits, single phasing conditions or other disturbances including zero sequence currents and ferroresonant over-voltages do not damage the Generator Owner's generating equipment. The protective equipment shall also prevent excessive or unnecessary tripping that would adversely affect the Company's service reliability to other Generator Owners and Customers.

6) The generator and interface protection schemes shall be continuously monitored and functioning and the generator shall immediately disconnect from the Company's system for any condition that would make the protection scheme inoperable.

7) The operating power required for the protection and control schemes for the generator and the control power used to disconnect the generator from the Company must not be dependent on local Company grid power.

8) Where multiple generators are connected to the system through a single point of common coupling, the sum of the ratings of the generators will be used to determine the applicability of these guidelines. Protection scheme performance with one or more units off line will have to be considered.

9) Applicable circuit breakers or other interrupting devices at the Generator Owner's facility must be capable of interrupting the maximum available local utility Company fault current at the site, including any contribution from the Owner's generator(s).

10) The Generator Owner will furnish and install a manual disconnect device which, when opened, will have the effect of isolating the generator from the Company's system. The disconnect device shall have a visible break (a disconnect switch, a draw-out circuit breaker, fuse block, etc. as appropriate to the voltage level), will at all times be accessible to the Company's personnel, and shall be capable of being locked in the open position via a Company padlock. The Company shall use reasonable efforts to utilize padlocks of a size consistent with typical manufacture's specifications. The Generator Owner shall follow the Company's switching, clearance and tagging procedures which the Company shall provide and attach the Warning Label noted in Section X.

11) The design, procurement, installation, and maintenance of the equipment at the Generator Owner's site are the responsibility of the Generator Owner and at the Generator Owner's expense.

12) Any necessary enhancements or improvements needed within the Company's system and/or at the Customer site(s) to accommodate the parallel interconnection of the Generator Owner's generation will be at the Generator Owner's expense.

13) The Generator Owner has full responsibility and liability for the safe and proper operation of their equipment and the power originating from their generator. The Generator Owner is also responsible for synchronizing their generator(s) with the Company's system and maintaining synchronous operation.

14) The Generator Owner must immediately cease parallel operation upon notification by the Company if such operation is determined to be unsafe, interferes with the supply of service to other customers, or interferes with the Company's system maintenance or operation.

15) The Company reserves the right to specify the type of transformer connection (e.g. delta-delta, wye-delta, wye-wye) that will be employed for all multiphase interface transformers consistent, where reasonable, with the Generator Owner's power system.

B) Prevention of Generator Owner Generation Interference with Company System. To eliminate undesirable interference caused by operation of the Generator Owner's generating equipment, the Generator Owner's generator shall meet the following criteria:

1) Voltage – The generating equipment will be operated in such a manner that the voltage levels on the Company's system are in the same range as if the generating equipment were not connected to the Company's system. The Generator Owner shall provide an automatic method of initiating a

disconnect sequence of his generating equipment from the Company system with set points noted in the table below.

Generating Systems with Inverters Up to 50kW	Generating Systems with Inverters Greater than 50kW	Non-Inverter or Rotating Machine Generating Systems
• Trip in 0.1 second for V<50% • Trip in 2 second for 50%≤V<88% • Trip in 2 seconds for 106%<V<137% • Trip in 0.03 second for 137%≤V (Above times and voltages taken directly from IEEE 929)	• Trip in 0.1 Second for V <50% • Trip within 0.1 to 30 seconds for 50%≤V<88% • Trip within 0.1 to 30 seconds for 106%<V<137% • Trip in 0.03 second for 137%≤V (Specific voltage and time delay set points will be determined for each installation.)	• Trip in 0.1 second for V < 50% or V ≥115% • Trip within 0.1 to 30 seconds for V>110% or V<90% (Specific voltage and time delay set points will be determined for each installation.)

Note: Trip time refers to the time between when the abnormal voltage condition occurs and the generator being completely disconnected from the utility Company.

On three phase generator installations, full three phase voltage sensing should be employed. Voltages must be sensed on the high side of any interface transformer if the transformer high voltage winding is ungrounded.

The Generator Owner may reconnect to the grid when the system voltage returns to normal range and is stabilized as defined in Section III, Definitions.

2) Flicker – The Generator Owner shall not cause excessive voltage flicker on the Company's system. This flicker shall not exceed the "Borderline of Irritation" curve, Fig. 10.3, as define in IEEE Std 519-1992, *Recommended Practices and Requirements for Harmonic Control in Electric Power Systems*. Lower levels of flicker may be required in areas where equipment such as computers and instrumentation are impacted.

3) Frequency – The operating frequency of the generating equipment shall not deviate more than the values noted in the table below.

Generating Systems with Inverters Up to 50kW	Generating Systems with Inverters Greater than 50kW	Non-Inverter or Rotating Machine Generating Systems
• Trip in 0.1 second for F<59.3 Hz • Trip in 0.1 second for F>60.5 Hz. (Set points taken from IEEE 929)	• Trip in 0.1 second for F<59.3 Hz • Trip in 0.1 second for F>60.5 Hz. (Other frequency and time delay set points may be necessary for a specific installation.)	• Trip in 0.1 second for F<59.3 Hz • Trip in 0.1 second for F>60.5 Hz. (Other frequency and time delay set points may be necessary for a specific installation.)

Note: Trip time refers to the time between when the abnormal frequency condition occurs and the generator being completely disconnected from the utility Company.

The Generator Owner may reconnect when the system frequency returns to normal range and is stabilized as defined in Section III, Definitions.

4) **Harmonics –** Non-linear circuit elements such as inverter can produce harmonics. Per IEEE std 519, *Recommended Practices and Requirements for Harmonic Control in Electric Power Systems*, Table 11.1, the total harmonic distortion (THD) voltage shall not exceed 5% of the fundamental 60 Hz frequency nor 3% of the fundamental for any individual harmonic as measured at the location where the customer interfaces with the Company's system (Point of Common Coupling). In addition, the level of harmonic current that the customer is allowed to inject into the Company's system shall not exceed that specified in Table 10.3 in IEEE Std 519. Furthermore, any communication notch should be limited as defined by Table 10.2 in IEEE Std 519. The preceding requirements apply to all types of generation systems.

   The Generator Owner is responsible for the installation of any necessary controls or hardware to limit the voltage and current harmonics generated by his equipment to defined levels.

5) **Power Factor –** The generator must not adversely impact the power factor of the Generator Owner site. Most inverters are designed to operate close to unity power factor. The operating power factor of the generator shall be contained within the limits defined in the table below.

Generating Systems with Inverters Up to 50kW	Generating Systems with Inverters Greater than 50kW	Non-Inverter or Rotating Machine Generating Systems
0.95 Lagging or Leading when output exceeds 10% of inverter rating. (From IEEE 929-1999)	0.95 Lagging or Leading When output exceeds 10% of inverter rating.	0.95 Lagging or Leading

   However, to the extent that a Generator Owner's power factor at the Point of Common Coupling falls below 0.95 lagging as a direct result of the installation of the generating unit(s), the Generator Owner must obtain, install and maintain, at his expense, corrective apparatus that compensates for the drop in power factor caused by the installation of the generator. Penalties will be assessed for power factors that fall below 0.95 lagging or leading.

6) **Current** – In some cases, directional over-current protection may be required to limit fault current flowing onto the Grid in the event of a line fault. DC inverters that are incapable of producing fault current do not require directional over-current protection.

   Inverter systems should not inject DC current greater than 0.5% of rated inverter output into the AC interface point under either normal or abnormal conditions.

7) **Fault and Line Clearing** – The Generator Owner shall automatically disconnect from the Company's system during electrical faults on the Company's electrical system and upon loss of the Company's electric source. The Generator Owner may reconnect when the system voltage and frequency return to normal range and is stabilized as defined in Section III, Definitions. Detection of the loss of the Company's primary electric system, where the Generator Owner is operating in an island with other customer load, becomes increasingly difficult as the level of distributed generation on a feeder approaches the connected load. For generating units 50kW and below, the over/under voltage and over/under frequency settings described previously along with

the anti-islandizing provisions of IEEE 929/UL 1746 inverters, should be sufficient to satisfy this provision.

8) **Automatic Reclosing** – The Generator Owner is responsible for protecting his equipment from the effects of switching or automatic reclosing of the Company's feeder circuit. The Generator Owner may request the Company to delay high speed reclosing on the Company's feeder to allow the interconnected generator sufficient time to remove itself from an islandized or de-energized feeder prior to automatic reclose. Since delaying the automatic reclose time degrades the level of service provided to other customers on the circuit, the Company will limit the automatic reclose time delays to a few seconds or less. The Generator Owner may also request that a direct transfer trip scheme be added to remove the interconnected Generator from service prior to automatic reclosing by using communications equipment between the generator site and the Company. Similarly the Generation Owner may request that a synchronizing check, or reclose blocking scheme be installed on the Company's feeder to prevent out of phase reclosing. The Generation Owner is responsible for all costs associated with the installation and maintenance of these requested modifications.

C. Control, Protection and Safety Equipment Requirements Specific to Generators of 50 kW or less.

All Generator Owners 50 kW or less can be single phase. Customer owned generators greater than 10 kW must be evaluated by the Company to determine if it can be single phase. The following table describes necessary control, protection and safety equipment specific to generator of 50kW or less connected to Secondary or Primary Voltage Systems:

Control, Protection and Safety Equipment for Generators of 50 kW[1] or Less Connected to Secondary or Primary System

Generator Size 50 kW or less	
Over-Current Trip	**X**
Over-Voltage Trip	**X**
Under Voltage Trip	**X**
Over/Under Frequency Trip	**X**
Synchronizing Check[2]	**Manual or Automatic**

Notes:

1. Exporting to the Company system many require additional operational/protection devices.
2. For synchronous and other type of generators with stand-alone capability.

D) Control, Protection and Safety Requirement Specific to Three Phase Synchronous Generators, Induction Generators, and Inverter Systems.

Generators greater than 50 kW must be three phase machines connected to three phase circuits.

1) **Three Phase Synchronous Generators.** Generator circuit breakers shall be three phase devices with electronic or electromechanical control. The Generation Owner is solely responsible for properly synchronizing his generator with the Company's system. For a synchronous generator, the excitation system response ratio shall not be less than 0.5 (five-tenths). The generator's excitation system(s) shall conform, as closely as reasonably achievable, to the field voltage vs. time criteria

specified in American National Standards Institute Standard C50.13-1989 in order to permit adequate field forcing during transient conditions.

2) **Three Phase Induction Generators and Inverter Systems.** Induction generation may be connected and brought up to synchronous speed (as an induction motor) if it can be demonstrated that the initial voltage drop measured on the Company's side at the point of common coupling is within the visible flicker limits stated in Section XIV.B.2. Otherwise, the Generator Owner may be required to install hardware use other techniques to bring voltage fluctuations to acceptable levels. Line-commutated inverters do not require synchronizing equipment. Self-commutated inverters whether of the utility-interactive type or stand-alone type shall be used in parallel with the Company system only with synchronizing equipment.

	Control, Protection and Safety Equipment[1] Greater than 25kW and Less than 50kW, Three Phase Connected to Primary System
Generator Disconnect Device	**X**
Over-Voltage Trip	**X**
Under Voltage Trip	**X**
Over-Current Trip	**X**
Over/Under Frequency Trip	**X**
Ground Over-Voltage Trip[2]	
OR	**X**
Ground Over-Current Trip[2]	
Synchronizing Check[3]	**Manual or Automatic**
Power Direction[4]	**X**
Transfer Trip/Reclose Blocking[5]	**X**

Notes:
1. Exporting to the Company's system may require additional operating/protection devices and will require coordination of operations with the Company.
2. Selection depends on grounding system, if required by the Company.
3. For synchronous and other types of generators with stand-alone capability.
4. Required only if generator size is greater than Generator Owner's minimum load and thus capable of exporting. The relay will operate if the power flow from the generator into the Grid exceeds a predetermined level. A time delay will have to be incorporated into this relaying scheme to prevent it from operating during synchronous swings.
5. May be required as part of any necessary transfer tripping/reclose blocking protection scheme.

E) Requirements Specific to Generators paralleling for 0.1 second or less (Closed Transition Switching)

The table below shows the protective functions required by this requirement for generators less than 50kW which parallel with the Company's system for 0.1 second or less such as during source or load transfers.

Control, Protection and Safety Equipment
Generators Connected to Secondary or primary System Voltage

For 0.1 Second or Less
(Closed Transition Switching)

	Generator Size **Up to 50kW**
Over-Voltage Trip	**X**
Under Voltage Trip	**X**
Synchronizing Check[1]	**Manual or Automatic**
Excessive Closed Time Trip[2]	**X**

Notes:
1. For synchronous and other types of generators with stand-alone capability.
2. Scheme will trip generator if closed transition parallel mode remains in effect longer than 0.1 second.

F) Inverter Type – DC Generation installations using inverters for interconnection with the Company must use non-islanding type inverters as defined in IEEE 929, *IEEE Recommended Practices for Utility Interface of Photovoltaic (PV) Systems* (including Annex B, D, E & G) and UL Subject 1741, May 1999, *Standard for Static Inverters and Charge Controllers for use in Photovoltaic Power Systems*.

G) Inspection and Start-Up Testing – the Generator Owner shall provide the Company with reasonable prior notice at least 2 weeks before the initial energizing and start-up testing of the Generator Owner's generating equipment and the Company, at its discretion, shall witness the testing of any equipment and protective systems associated with the interconnection. The Generator Owner shall revise and re-submit the application information for any proposed modification that may affect the safe and reliable operation of the Company's system. The generator may be reconnected to the Company system only after the modified application has been reviewed, testing has been confirmed and the Company has given approval to reconnect.

H) Site Testing and Commissioning - Testing of protection systems shall include procedures to functionally test all protective elements of the installation up to and including tripping of the generator and interconnection point. Testing and testing intervals should be in accordance with manufacturers' and industry recommendations. Testing will verify all protective set points and relay/breaker trip timing. The Company may witness the testing of installed switchgear, protection systems, and generator. The Generator Owner is responsible for all maintenance of the generator, control and protective equipment. The Generator Owner will maintain records of such maintenance activities which the Company may review at reasonable times.

I) Metering - Metering requirements will be reviewed on each specific installation.

J) Dedicated Transformer – A dedicated transformer will be required where the generating Generator Owner is served from the same transformer secondary as another Company customer and inverter-based technology not meeting IEEE 929-1999 and IEEE 519-1992 specifications is used. In addition, a dedicated transformer or other current-limiting device is needed for any type of generator installation where the increase in available short circuit current could adversely impact other Company customers on the same secondary circuit.

K) Suggested References

The following references can supply technical support and insight into the safe, reliable interconnection of distributed generation with the Company's systems. These references should be reviewed by those individuals or firms contemplating parallel operation of generation with the Company.

IEEE C37.95-1989 - *IEEE Guide for Protective Relaying of Utility-Consumer Interconnections*

IEEE Std 1001 (1988) - *IEEE Guide for Interfacing Dispersed Storage and Generation Facilities with Electric Utility Systems*

IEEE Std 929 - *IEEE Recommended Practices for Utility Interface of Photovoltaic (PV) Systems*

IEEE Std 1021 (1988) - *IEEE Recommended Practices for Utility Interconnection of Small Wind Energy Conversion Systems*

IEEE Std 519 -1992 - *IEEE Recommended Practices and Requirements for Harmonic Control In Electrical Power Systems*