

FIRST READING: 07/16/07
SECOND READING: 08/06/07
THIRD READING: 09/04/07
SPONSOR: _____
ORD. NO.: 009-07
REFERRED TO: Utility Committee

**Technical Considerations Covering Parallel Operations
of Customer Owned Generation of Less than One (1) Megawatt
and Interconnected with the Town of Smyrna Electric System**

Prerequisite - The customer must be first 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 1 Megawatt which is interconnected at 25kV or below and operated in parallel with the Town's power delivery System. The technical requirements of Section XIV and subsequent sections of this document do not apply to 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. (The Town, by reference, adopts the above standards and future updates of these standards as appropriate.)

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. A premises may have more than one account.

B. Town - Town of Smyrna

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 Electric Service from the Town 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 1 MW, which may be connected in parallel operation to the Town's system.

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

F. Grid - The interconnected arrangement of lines and transformers that make up the Town'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 Town'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 Town for permission to interconnect with the Town system. The approved Interconnection Application sets forth the contractual conditions under which the Town and Generator Owner agree that one or more generating units whose aggregate generation at the Point of Common Coupling is less than 1 MW may be interconnected at 25 kV or less with the Town'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 Town's system and the Generator Owner's generating source.
- M. Point of Common Coupling** - The point where the electrical conductors of the Town system are connected to the Customer's conductors and where any transfer of electric power between the Generator Owner and the Town 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 Town as meeting the applicable parts of this document.
- O. Pre-Interconnection Study** - A study or studies which may be undertaken by the Town in response to its receipt of a completed application for parallel operation with the Town'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 Town'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 Town. The Town 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** - Town's distribution system operating at 25 kilovolts or below to which the generation equipment is interconnected.

IV. Interconnection Application - A proposed Generator Owner will make a formal application to the Town for the interconnection of a generator to the Town system. All applications are to be sent to the Town's Business Office. The application will be prepared on an Application Form provided by the Town. Two Application Forms are available. Generators 25 kW or less will use the shorter Application Form as less technical data is needed for units within this size range.

V. Designation of Town Contact Persons for Technical Matters Relating to Distributed Generation Interconnection - The Town's Electrical Engineers will be the designated point of contact for all technical matters related to interconnected generation. The Town 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, technical evaluation of the application and the final disposition of such application.

VI. Pre-Interconnection Studies - In many instances, the Town 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 Town will notify the Generator Owner that his application has been approved or indicate in sufficient detail why the application cannot be approved. The conducting of such pre-interconnection studies shall not unduly delay the interconnection of the distributed generation. The Town of Smyrna will make every effort to complete the pre-interconnection study in a timely manner after receipt of signed customer application and complete customer submittal of all required data.
- B. Pre-interconnection Study Fee** - For all generators less than 25 kW the Town may do a pre-interconnection study without charge up to the typical and customary cost that the Town would expend for study work of similar type of customer interconnection. If the cost to the Town is expected to exceed this typical and customary amount, or if multiple submittals by the Generator Owner are necessary, or if the generators are greater in size than 25 kW, the Town will advise the Generator Owner of the expected cost of such study work by the Town before such work begins. The Generator Owner will be responsible for payment of any costs prior to the commencement of the Pre-interconnection Study.

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 Town 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 Town'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 Town systems at the point of the interconnection.

IX. Connection Approval - The Generator Owner can connect their generation to the Town system only after the Interconnection Application has been approved and the Generation Owner has received approval notification. The Town will make every effort to provide notification in a timely manner following the receipt of the Interconnection Application and all required data.

X. Interconnected Generation Site Warning Label - The Town will install a warning label in a conspicuous place on their electric meter or meter box to notify the Town 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 Town personnel to read the electric meter. The Town 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 Town may disconnect a distributed generation unit under the following conditions:

- A. **Application Termination** - Upon termination of the approved Interconnection Application.
- B. **Non Compliance** - For non-compliance with the technical guidelines specified in this document or other requirement contained in the applicable Customer Tariff, provided that the Town has given notice to the Generator Owner and provided the Generator Owner reasonable time (consistent with the condition) to correct such non-compliance. The Town will reconnect the unit only upon receipt of certification from the Generator Owner and verification by the Town that the unit is in compliance. The Town will determine at the Town's sole judgment if the Customer's generation is in compliance. The Town will provide verification within a reasonable time period.
- C. **In Case of a system emergency outage of the Town'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 Town's electric source in accordance with these guidelines. The Generation Owner must also cease parallel operation upon notification by the Town 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 Town's system maintenance or operation. In addition, the Town may disconnect the generator from the system for system emergencies without notice. However, the Town will use reasonable efforts to notify the Generation Owner prior to disconnecting.

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

The Town will reconnect the Customer/Generation Owner as quickly as possible 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 Town. The Town may terminate the Interconnection Application for cause after 30 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 Town notice that it intends to permanently shut down its generation. In no respect will notice to terminate preclude the Town from taking any and all immediate actions necessary, including temporary or permanent disconnection of Customer's generation, if the Town is aware of safety, or reliability concerns as a result of interconnection of the Customer's 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 Town with detailed information concerning the proposed distributed generation project. The Town 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 Town, or others in conjunction with the Town, 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 Town's system pursuant to an approved Interconnection Application provided that the equipment and Generator Owner meet or exceed the requirements of these guidelines and that the Town 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 settings or hardware, especially when exporting power to the system. If the Town concludes that an application for parallel operation requires additional protective settings or hardware, the Town shall make those requirements known to the Generator Owner in a timely fashion after all pertinent studies are completed.

Approval to connect to the Town 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. The Town accepts no responsibility for activities or events on the Customer's side of the Interconnection.

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 Town's de-energized circuits. The Generator Owner's generator must automatically disconnect from the Town's system if the Grid source is lost, irrespectively of connected 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 Town'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 Town 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 Town's service reliability or power quality 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 Town'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 Town must not be dependent on local Town grid power, or

must provide a "fail-safe" method to an "open" disconnected position upon loss of grid.

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

On generation installations of 25 kW or less, the Generator Owner may request, and the Town of Smyrna in its sole judgment and discretion may allow the Generation Owner to not install a manual disconnect switch provided that the meter can be safely "pulled" by the Town to isolate the generation equipment from the Town. **If the Generator Owner is permitted by the Town of Smyrna to not install a manual disconnect device, the Generator Owner assumes all risks and consequences when a meter must be "pulled" to disconnect the generator thereby also interrupting electric service to the Customer.**

- 11) The design, procurement, installation and maintenance of the equipment at the Generator Owner's

site is the responsibility of the Generator Owner and at the Generator Owner's expense.

- 12) Any necessary enhancements or improvements needed within the Town's system and/or at the Customer sites 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 Town's system and maintaining a synchronous operation.
- 14) The Generator Owner must immediately cease parallel operation upon notification by the Town if such operation is determined to be unsafe, interferes with the supply of service to other customers or interferes with the Town's system maintenance or operation.
- 15) The Town 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 Town 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 Town's system are in the same range as if the generating equipment were not connected to the Town's system. The Generator Owner shall provide an automatic method of initiating a disconnect sequence of his generating equipment from the Town system with set points noted in the table below.

Generating Systems with Inverters Up to 25 kW	Generating Systems with Inverters Greater than 25 kW	Non-Inverter or Rotating Machine Generating Systems
<ul style="list-style-type: none"> • Trip in 0.1 second for $V < 50\%$ • Trip in 2 second for $50\% \leq V < 88\%$ • Trip in 2 seconds for $106\% < V < 137\%$ • Trip in 0.03 second for $137\% \leq V$ <p>(Above times and voltages taken directly from IEEE 929)</p>	<ul style="list-style-type: none"> • Trip in 0.1 Second for $V < 50\%$ • Trip within 0.1 to 30 seconds for $50\% \leq V < 88\%$ • Trip within 0.1 to 30 seconds for $106\% < V < 137\%$ • Trip in 0.03 second for $137\% \leq V$ <p>(Specific voltage and time delay set points will be determined for each installation.)</p>	<ul style="list-style-type: none"> • Trip in 0.1 second for $V \geq 115\%$ • Trip within 0.1 to 30 seconds for $V > 110\%$ or $V < 90\%$ <p>(Specific voltage and time delay set points will be determined for each installation.)</p>

Note: Trip time refers to the time between when the abnormal voltage condition occurs and the generator being disconnected from the Town's Electric System.

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 Town's system. This flicker shall not exceed the "Borderline of Irritation" curve, Fig. 10.3, as defined in IEEE Std 519-1992, *Recommended Practices and Requirements for Harmonic Control in Electric Power Systems* (See Appendix 1). 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 25 kW	Generating Systems with Inverters Greater than 25 kW	Non-Inverter or Rotating Machine Generating Systems
<ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> • 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.)	<ul style="list-style-type: none"> • 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 disconnected from the Town's Electric System.

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 inverters can produce harmonics. Per IEEE std 519, *Recommended Practices and Requirements for Harmonic Control in Electric Power Systems*, Table 11.1 (See Appendix 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 Town's system (Point of Common Coupling). In addition, the level of harmonic current that the customer is allowed to inject into the Town's system shall not exceed that specified in Table 10.3 in IEEE Std 519 (See Appendix 1). Furthermore, any communication notch should be limited as defined by Table 10.2 in IEEE Std 519 (See Appendix

1). 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 25 kW	Generating Systems with Inverters Greater than 25 kW	Non-Inverter or Rotating Machine Generating Systems
0.85 Lagging or Leading when output exceeds 10% of inverter rating. (From IEEE 929-1999)	0.85 Lagging or Leading When output exceeds 10% of inverter rating.	0.85 Lagging or Leading

However, to the extent that a Generator Owner's power factor at the Point of Common Coupling falls below 0.9 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.

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 in the AC interface point under either normal or abnormal conditions.

7) Fault and Line Clearing - The Generator Owner shall automatically disconnect from the Town's system during electrical faults on the Town's electrical system and upon loss of the Town'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 Town's primary electric system, where the Generator Owner is operating in an island with other customer load, becomes increasingly difficult as the level of dispersed generation on a feeder approaches the connected load. For generating units 25 kW 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. For units greater than 25 kW the voltage and frequency set-points are to be adjustable, with the actual setting determined by the Town based on the electrical characteristics of the generator and the Town's electrical system. In addition, additional protection such as power directional or directional overcurrent functions may be required. For units 500 kW or larger, a direct tripping scheme to trip the generator upon loss of the Town's feeder may be required by the Town. This decision will be based on the saturation of distributed generation on a particular feeder circuit and in those cases where under voltage or under frequency sensing may not adequately detect loss of the Town source.

8) Automatic Reclosing - The Generator Owner is responsible for protecting his equipment from the effects of switching or automatic reclosing of the Town's feeder circuit. The Generator Owner may request the Town to delay high speed reclosing on the Town'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 Town 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 Town. Similarly, the Generation Owner may request that a synchronizing check, or reclose blocking scheme be installed on the Town'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 25 kW or less

All Generator Owners 10 kW or less can be single phase. Customer owned generators greater than 10 kW must be evaluated by the Town to determine if it can be single phase. The following table describes necessary control, protection and safety equipment specific to generators of 25 kW or less connected to Secondary or Primary Voltage Systems:

Control, Protection and Safety Equipment for Generators of 25 kW¹ or Less Connected to Secondary or Primary System
Generator Size 25 kW or less

<u>Generator Disconnect Device²</u>		X
<u>Over-Current Trip</u>	X	
<u>Over-Voltage Trip</u>	X	
<u>Under Voltage Trip</u>		X
<u>Over/Under Frequency Trip</u>		X
<u>Synchronizing Check³</u>		Manual or Automatic

Notes:

1. Exporting to the Town system may require additional operational/protection devices.
2. Generator Owner may request to have the meter act as the disconnect device.
(See XIV.A.10)
3. 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 25 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 Town's system. For a synchronous generator, the excitation system response ratio shall not be less than 0.5 (five-tenth). The generator's excitation system(s) shall conform, as near 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 Town'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 or 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 Town system only with synchronizing equipment.

Control, Protection and Safety Equipment¹ Less than 1 MW Three Phase Connected to Primary System (and greater than 25 kW)

<u>Generator Disconnect Device²</u>	X	
<u>Over-Voltage Trip</u>	X	
<u>Under Voltage Trip</u>	X	
<u>Over-Current Trip</u>	X	
<u>Over/Under Frequency Trip</u>	X	
<u>Ground Over-Voltage Trip³</u>		
OR	X	
<u>Ground Over-Current Trip³</u>		
<u>Synchronizing Check⁴</u>		Manual or Automatic
<u>Power Direction⁵</u>	X	
<u>Transfer Trip/Reclose Blocking⁶</u>		X

Notes:

1. Exporting to the Town's system may require additional operating/protection devices and will require coordination of operations with the Town.
2. For installations of 25 kW or less, the Generation Owner may request to have the meter act as the disconnect device (See XIV.A.10).
3. Selection depends on grounding system, if required, by the Town.
4. For synchronous and other types of generators with stand-alone capability.
5. 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 relay to prevent it from operating during synchronous swings.
6. 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 1 MW which parallel with the Town'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 1 MW

<u>Over-Voltage Trip</u>	X
<u>Under Voltage Trip</u>	X
<u>Synchronizing Check</u>¹	Manual or Automatic
<u>Excessive Closed Time Trip</u>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 Town 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 Town 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 Town, 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 Town's system. The generator may be reconnected to the Town system only after the modified application has been reviewed, testing has been confirmed and the Town 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 Town 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 Town may review at reasonable times. For generation systems greater than 500 kW, a log of generator operations may be required in order to determine its output and run times for system planning purposes.

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 Town 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 Town 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 Town's systems. These references should be reviewed by those individuals or firms contemplating parallel operation of generation with the Town.

- 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*

This ordinance shall become effective 09/19/07.

SYNOPSIS

This amending ordinance adopts the Technical Considerations Covering Parallel Operation of Customer Owned Generation Of Less than One (1) Megawatt And Interconnected with the Smyrna Electric System and Net Metering Policy For Parallel Operations of Customer Owned Generation regarding customer owned generation.

Appendix 1

Selected Tables from IEEE Std. 519-1992

Recommended Practices and Requirements for Harmonic Control in
Electric Power Systems

Figure 10-3 Maximum Permissible Voltage Fluctuations

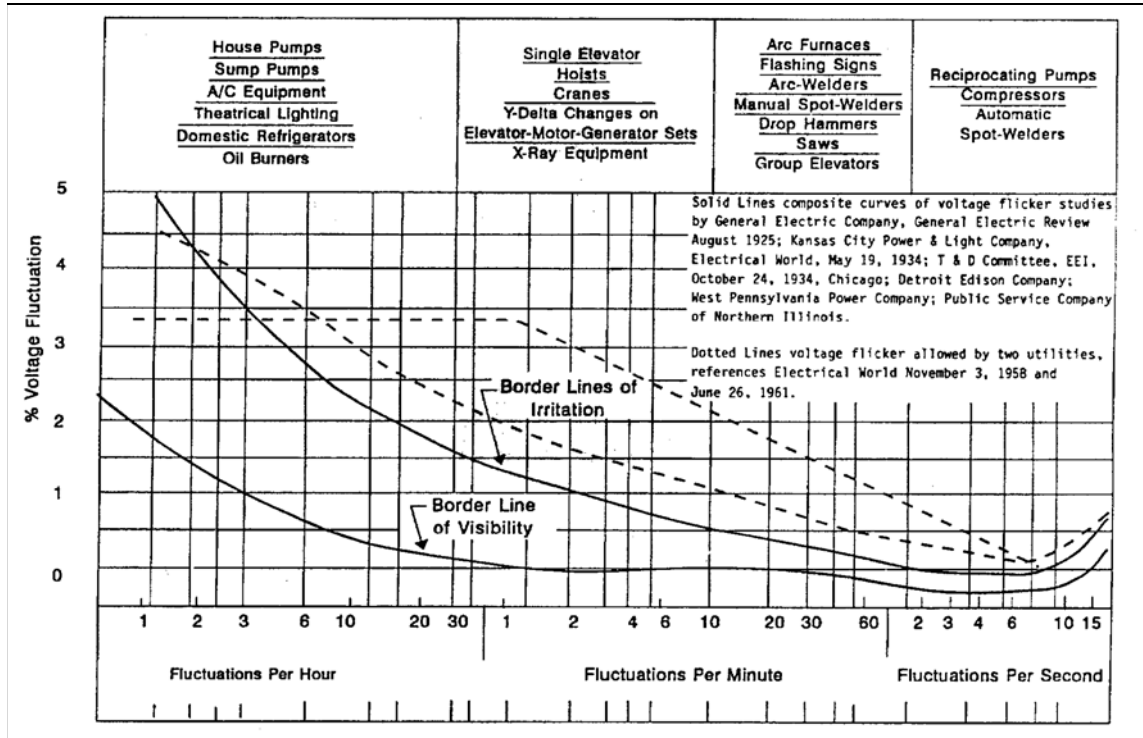


Table 10-2—Low-Voltage System Classification and Distortion Limits

	Special Applications*	General System	Dedicated System†
Notch Depth	10%	20%	50%
THD (Voltage)	3%	5%	10%
Notch Area (A_N)‡	16 400	22 800	36 500

NOTE — The value A_N for other than 480 V systems should be multiplied by $V/480$

*Special applications include hospitals and airports.

†A dedicated system is exclusively dedicated to the converter load.

‡In volt-microseconds at rated voltage and current.

From IEEE Std 519-1992. Reprinted with permission from IEEE

Table 10-3—Current Distortion Limits for General Distribution Systems (120 V Through 69 000 V)

Maximum Harmonic Current Distortion in Percent of I_L						
Individual Harmonic Order (Odd Harmonics)						
I_{sc}/I_L	<11	11≤h<17	17≤h<23	23≤h<35	35≤h	TDD
<20*	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

Even harmonics are limited to 25% of the odd harmonic limits above.

Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

* All power generation equipment is limited to these values of current distortion, regardless of actual I_{sc}/I_L .

where
 I_{sc} = maximum short-circuit current at PCC.
 I_L = maximum demand load current (fundamental frequency component) at PCC.

Table 11-1—Voltage Distortion Limits

Bus Voltage at PCC	Individual Voltage Distortion (%)	Total Voltage Distortion THD (%)
69 kV and below	3.0	5.0
69.001 kV through 161 kV	1.5	2.5
161.001 kV and above	1.0	1.5

NOTE — High-voltage systems can have up to 2.0% THD where the cause is an HVDC terminal that will attenuate by the time it is tapped for a user.

From IEEE Std 519-1992. Reprinted with permission from IEEE

Appendix 2

Generator Interconnection Application - Short Form
(For Use with Generators 25 kW or Less)

Town of Smyrna
Generator Interconnection Application -Short Form
(For Use with Generators 25 kW or Less)

An applicant (Generator Owner) makes application to Town of Smyrna to install and operate a generating facility of 25 kW or less interconnected with the Smyrna Electric system.

Section 1 - Applicant Information

Name: _____

Mailing Address: _____

City: _____

State: _____ Zip Code: _____

Facility Location (if different from above): _____

Telephone (Daytime): (____) _____ Telephone
(Evening) (____) _____

Section 2 - Generator Qualifications

Is Generator powered from a Renewable NEM Qualifying Energy Source: Yes No

Type NEM Qualifying Energy Source (if applicable):

Solar Wind Hydro

Generator (or solar collector) Manufacturer, Model Name & Number: _____

_____ Output Power Rating in
kW: _____

Inverter Manufacturer, Model Name & Number (if used):

Rating in kW: _____

Will a generator disconnect device, accessible to the local utility be installed? Yes No

If the Generator Owner is permitted by the Town of Smyrna to not install a manual disconnect device accessible to the local utility (See Section XIV A.10), the Generator Owner assumes the risks and consequences when a service meter must be "pulled" to disconnect the generator thereby interrupting all utility electric service to the Customer site.

Town of Smyrna
Generator Interconnection Application -Short Form
(For Use with Generators 25 kW or Less)

Section 3 - Generator / Equipment Certification

Generating systems that use/utilize inverter technology must be compliant with the *IEEE 929* and *Underwriter Lab UL 1741*. Generating systems that use a rotating machine must be compliant with the *Town of Smyrna's Technical Considerations Covering Parallel Operations of Customer Owned Generation of Less than One (1) MW and Interconnected with the Smyrna Electric System* document. By signing below, the Applicant certifies that the installed generating equipment meets the appropriate preceding requirement(s) and can supply documentation that confirms compliance.

Signed (Applicant):

Date:

Section 4 - Installation Details

Generating System will be installed by:

State Licensed Electrician

Owner

Installing Technician:

_____ Firm: _____ License

No.: _____

Mailing Address:

City: _____

State: _____ Zip Code: _____

Telephone Number: (_____) - _____

Installation Date: _____ Interconnection

Date: _____

Supply Certification that the generation system has been installed and inspected in compliance with the local Building /Electrical code.

Signed (Inspector):

Date: _____

(In lieu of signature of Inspector, a copy of the final inspection certificate may be attached.)

Section 5 - Application Fee

Application fee as listed in the Town of Smyrna's Fee Schedule and is to be paid by Applicant when the Application is submitted to the Town of Smyrna Business Office.

Town of Smyrna
Generator Interconnection Application -Short Form
(For Use with Generators 25 kW or Less)

Section 6 - Applicant Signature

I hereby certify that, to the best of my knowledge, all the information provided in the Interconnection Application is true and correct. I also agree to install a Warning Label provided by the local utility on or near my service meter location.

Signature of Applicant: _____

Date: _____

Send the completed application to The Town of Smyrna, P. O. Box 307, 27 South Market Street Plaza, Smyrna, Delaware 19977, Attention: Business Office.

Section 7 - Approval or Non-Approval

The Town of Smyrna: Has Approved Has Not Approved

Name: _____

Date: _____

Signature: _____

Reason for Non- Approval: _____

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

Section 8 - Internal Notifications

Send Applicant Warning Label for installing on/near service meter: Yes

Notify Billing Department of Interconnected Generation: Yes

Notify Electric Department of Interconnected Generation:

	<input type="checkbox"/>	Yes
Application Fee Paid:	<input type="checkbox"/>	Yes
DEMEC Notified	<input type="checkbox"/>	Yes
Copy of Final Inspection Certificate (or Signature)	<input type="checkbox"/>	Yes

Appendix 3

Generator Interconnection Application - Long Form
(For Use with Generators Greater than 25 kW and Less than 1 MW)

Town of Smyrna

Generator Interconnection Application -Long Form

(For Use with Generators Greater than 25 kW and Less than 1 MW)

An applicant (Generator Owner) makes application to Town of Smyrna to install and operate a generating facility greater than 25 kW and less than 1 MW interconnected with the Smyrna Electric system.

Section 1 - Applicant Information

Name:

Mailing Address:

City: _____

State: _____ Zip Code: _____

Facility Location (if different from above):

Telephone (Daytime): Area Code _____ (Evening)

Area Code _____

Town of Smyrna Account No. :

Energy Service Provider Name: _____

Account No.: _____

Section 2 - Generator Qualifications

Is the generator a Qualifying Facility as defined under Subpart B, Section 201 of the Federal Energy Regulatory Commission's regulations per the Public Utility Regulatory Policies Act of 1978? Yes No

Is Generator powered from a Renewable Qualifying Energy Source:
 Yes No

Type Qualifying Energy Source (if applicable):

Solar Wind Hydro

Other generator energy source: Natural Gas

Fuel Oil Other: _____

Will excess power be exported to Town of Smyrna? Yes
No

Site Load: _____ kW (Typical) Maximum Export:
_____ kW.

Section 3 - Generator Technical Information

Type of Generator: Synchronous Induction
 DC Generator or Solar with Inverter

Generator (or solar collector) Manufacturer, Model Name &
Number: _____
**(A copy of Generator Nameplate and Manufacturer's Specification
Sheet may be substituted)**

_____ Output Power
Rating in kW: _____

Town of Smyrna
Generator Interconnection Application -Long Form

Inverter Manufacturer, Model Name & Number (if used):

**(A copy of Inverter Nameplate and Manufacturer's Specification
Sheet may be substituted)**

_____ Rating in kW:

Generator Characteristic Data (for rotating machines):
**(Not needed if Generator Nameplate and Manufacture's
Specification Sheet is provided)**

Direct Axis Synchronous Reactance, X_d : _____ P.U.
Negative Sequence Reactance: _____ P.U.
Ddirect Axis Transient Reactance, X'_d : _____ P.U.
Zero Sequence Reactance: _____ P.U.
Direct Axis Subtransient Reactance, X''_d : _____ P.U.
KVA Base: _____

Section 4 - Interconnecting Equipment Technical Data

Will an interposing transformer be used between the generator
and the point of interconnection? Yes No

Transformer Data (if applicable, for Customer Owned
Transformer): _____

(A copy of transformer Nameplate and Manufacturer's Test Report may be substituted)

Size: _____ KVA . Transformer Primary : _____
Volts Delta Wye Wye Grounded

Secondary: _____ Volts Delta Wye Wye
Grounded

Transformer Impedance: _____ % on _____ KVA Base

Transformer Fuse Data (if applicable, for Customer Owned Fuse):
(Attach copy of fuse manufacturer's Minimum Melt & Total Clearing Time-Current Curves)

Manufacturer: _____ Type: _____ Size: _____
Speed: _____

Interconnecting Circuit Breaker (if applicable):
(A copy of breaker's Nameplate and Specification Sheet may be substituted)

Manufacturer: _____ Type: _____ Load Rating: _____
Interrupting Rating: _____ Trip Speed: _____

(Amps) **(Amps)**

(Cycles)

Circuit Breaker Protective Relays (if applicable):
(Enclose copy of any proposed Time-Overcurrent Coordination Curves)

Manufacturer: _____ Type: _____
Style/Catalog No.: _____ Proposed Setting: _____

Manufacturer: _____ Type: _____
Style/Catalog No.: _____ Proposed Setting: _____

Manufacturer: _____ Type: _____
Style/Catalog No.: _____ Proposed Setting: _____

Manufacturer: _____ Type: _____
Style/Catalog No.: _____ Proposed Setting: _____

Manufacturer: _____ Type: _____
Style/Catalog No.: _____ Proposed Setting: _____

Town of Smyrna
Generator Interconnection Application -Long Form

Current Transformer Data (if applicable):
(Enclose copy of Manufacturer's Excitation & Ratio Correction Curves)

Manufacturer: _____ Type: _____ Accuracy Class: _____
_____ Proposed Ratio Connection: _____/5

Manufacturer: _____ Type: _____ Accuracy Class: _____
_____ Proposed Ratio Connection: _____/5

Generator Disconnect Switch:

A generator disconnect device, accessible to the Town of Smyrna, **must be included** for all generators greater than 25 kW.

Manufacturer: _____ Type: _____ Catalog No.: _____
Rated Volts: _____ Rated Amps: _____

Single or 3 Phase: _____

Mounting Location: _____

Section 5 - General Technical Information

Enclose copy of site One-Line Diagram showing configuration and interconnection of all equipment, current and potential circuits and protection and control schemes. Is One-Line Diagram Enclosed? Yes

Enclose copy of any site documentation that describes and details the operation of the protection and control schemes. Is Any Available Documentation Enclosed? Yes

Enclose copies of schematic drawings for all protection and control circuits, relay current circuits, relay potential circuits, and alarm/monitoring circuits. Are Schematic Drawings Enclosed? Yes

Section 6 - Installation Details

Generating System will be installed by: Owner
 State Licensed Electrician

Installing Electrician: _____
Firm: _____ License No.: _____

Mailing Address:

City: _____ State: _____ Zip Code: _____

Telephone: Area Code: (_____) Number: _____

Installation Date: _____

Interconnection Date: _____

Supply certification that the generating system has been installed and inspected in compliance with the local Building/Electrical code.

Signed (Inspector): _____

Date: _____

**(In lieu of signature of
Inspector, a copy of the final inspection certificate may be
attached)**

Town of Smyrna
Generator Interconnection Application -Long Form

Section 7 - Generator/Equipment Certification

Generating systems that use / utilize inverter technology must be compliant with IEEE 929 and *Underwriters Lab. UL 1741*. Generating systems that use a rotating machine must be compliant with Town of Smyrna's *Technical Considerations Covering Parallel Operations of Customer Owned Generation of Less than One (1) MW and Interconnected with the Smyrna Electric System* document. **By signing below, the Applicant certifies that the installed generating equipment meets the appropriate preceding requirement(s) and can supply documentation that confirms compliance.**

Signed (Applicant): _____

Date: _____

A Pre-Interconnection Study is normally required for generators greater than 25 kW. However, certain generator types/sizes and the location of the Point of Interconnection with Smyrna Electric System may permit a waiver of the Pre-Interconnection Study.

Does the Generation Owner request a waiver of the Pre-Interconnection Study? Yes No

A "Yes" response cannot insure that the Pre-Interconnection Study requirement will be waived. Town of Smyrna has the sole authority to grant release from the requirement based on the merits of each individual Interconnection Application.

Section 8 Application Fee

Application Fee is listed in the Town of Smyrna's Fee Schedule and is to be paid by Applicant when Application is submitted to the Town of Smyrna Business Office.

Section 9 - Applicant Signature

I hereby certify that, to the best of my knowledge, all the information provided in the Interconnection Application is true and correct. I also agree to install a Warning Label provided by Town of Smyrna on or near my service meter location.

Signature of Applicant: _____
Date: _____

Send the completed application to Town of Smyrna, P.O. Box 307,
27 South Market Street Plaza, Smyrna, Delaware 19977, Attention
Business Office

Town of Smyrna
Generator Interconnection Application -Long Form
(For Use with Generators Greater than 25 kW and Less than 1 MW)

This Section for use by Town of Smyrna Only

Section 10 - Approval or Non-Approval

Town of Smyrna: Has Approved Has Not Approved this Interconnection Application.

Name: _____ Date: _____

Signature: _____

Reason of Not Approving: _____

Approval to connect to the Smyrna Electrical 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.

Section 11 - Internal Notifications

- | | |
|---|------------------------------|
| Send Applicant Warning Label for installing on/ near service meter: | <input type="checkbox"/> Yes |
| Notify Billing Dept. of Interconnected Generation: | <input type="checkbox"/> Yes |
| Notify Electric Department of Interconnected Generation: | <input type="checkbox"/> Yes |
| Application Fee Paid: | <input type="checkbox"/> Yes |
| DEMEC Notified | <input type="checkbox"/> Yes |
| Copy of Final Inspection Certificate (or Signature) | <input type="checkbox"/> Yes |

This will certify that this is a true and correct copy of the Ordinance duly adopted by the Town Council of the Town of Smyrna at its regular Council meeting on _____.

ATTEST:

Council Secretary

Mayor

This shall certify that the title and synopsis of this ordinance were published in the Smyrna/Clayton Sun Times on 7/25/07 and posted at the Town Hall on 7/17/07.

So Certifies:

Town Clerk

This shall certify that the title, effective date and synopsis of this Ordinance was published in the Smyrna/Clayton Sun Times on 09/12/07 and posted at the Town Hall on 09/06/07.

So Certifies:

Town Clerk