



# Electrical Guidelines for Inverter-Based Micro-Generating Facility

10 KW and Smaller



**Cover: Photos courtesy of Balance Solutions for Today Inc**

## OVERVIEW

Today many home, farm and small business owners are considering the installation of alternative forms of electricity generation (distributed generation) and connecting them to run in parallel with the Local Distribution Company (utility) electrical system. This may include the installation of small wind turbines, photovoltaic (solar) systems, micro-hydro turbines or fuel cells. These systems are intended to reduce the amount of power purchased from the local electricity distribution company and where they are powered from renewable sources such as wind, flowing water or sunlight they also provide environmental benefits.

Any system that produces even small amounts of electricity can be potentially dangerous, creating the possibility of electrocution and fire hazards. Improperly installed systems will create serious safety hazards to property owners, their friends, family, employees and local electric distribution company workers.

Before installing any type of distributed generation, whether it is stand-alone or connected to the grid, it is important to understand the safety requirements. The safety regulations, the codes and the associated safety technical standards can be confusing and difficult to understand. This guideline is intended to simplify these and provide basic safety advice to home, farm and business owners who are considering the installation of distributed generation systems.

This guideline is based on the requirements of the Electrical Safety Authority's Ontario Electrical Safety Code (OESC) and the Ontario Energy Board's Distribution System Code.

With the introduction of amendments to the Distribution System Code it is currently much easier to connect generators to the distribution systems. These amendments will allow for standardization, consistency and clarity with regards to procedures and requirements for facilitating connection of new generation facilities to local distribution systems. The intent is to facilitate the installation and connection of alternative or renewable sources of energy generation, such as photovoltaic systems, wind generators, micro turbines, and fuel cell technologies.

This guideline is intended to serve a very specific need of inverter based micro embedded load displacement generation and is in no way intended to be used as a substitute for the Ontario Electrical Safety Code. Omission of any requirements presently in the OESC does not in any way affect the OESC, nor should these omitted requirements be considered unimportant. They are essential to the OESC and its intended application, that is, its use by those who design, install, and inspect electrical installations.

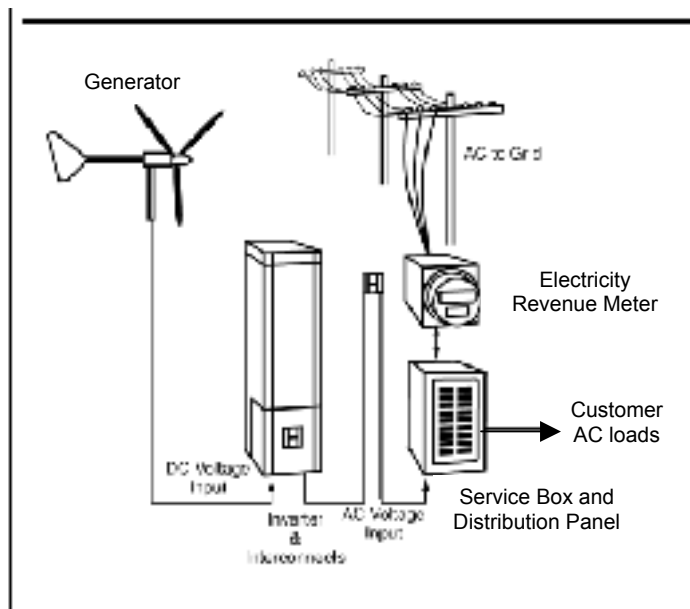
## TYPES OF DISTRIBUTED GENERATION

The Distribution System Code describes four categories of distributed generation.

Generator Classification	Rating
Micro	≤ 10 kW, for customer's own use
Small	(a) ≤ 500 kW connected on distribution system voltage < 15 kV  (b) ≤ 1 MW connected on distribution system voltage ≥ 15 kV
Mid-Sized	(a) < 10 MW but > 500 kW connected on distribution system voltage < 15 kV  (b) > 1 MW but < 10 MW connected on distribution system voltage ≥ 15 kV
Large	≥ 10 MW

This guideline deals only with the installation of micro generation facilities for load displacement. The larger generator units are more complex and require design and installation plans. For these larger installations, plans will have to be submitted to the Local Distribution Company and the Electrical Safety Authority for review and approval before any installation work begins.

## TYPICAL MICRO GENERATION SYSTEM



**FIGURE 1.** Diagram of a grid-tied wind electric system with “DG system disconnect”  
(Source: Phantom Electron Corp.)

## DEFINITIONS

**Anti Islanding:** The generator shall cease to generate power in the event of loss of LDC supply, and will not provide backup power in the event of loss of LDC supply

**Approved Electrical Equipment:** All electrical equipment must, by law, be approved by, and bear a certification mark of one of the accredited certification organizations labels affixed to the electrical equipment, The presence of a mark or label confirms to the user that the equipment is in compliance with the Ontario regulations. . (Refer to Appendix A of this document or ESA Bulletin 2-7-# for examples of the marks of accredited certification organizations)

If the equipment you are considering does not have one of these certification marks identified in appendix A, its safety cannot be assured and it shall not be installed or used.

**Disconnecting means:** A device, group of devices, or other means whereby the conductors of a circuit can be disconnected from their source of supply

**Distributed Generator (DG) Source Disconnect:** Every installation shall have a disconnecting switch or other approved disconnecting device. The disconnect is required to enable the disconnection of the generating system from the home, farm or buildings electrical wiring system and from the utility system.

**Distributed Generator (DG) System Disconnect:** Many LDC's will require a second disconnect. This disconnect will usually be located near the electricity meter and should be accessible to local electric utility staff. This disconnect is required to ensure the safety of electrical utility workers. This disconnect will allow utility staff to disconnect the generator from the utility system in case they have to service or repair the electrical supply to your home, farm or business. This disconnect provides an assurance to the utility workers that your generator cannot energize the electrical wires while they are working on them. The local electric utility will specify the location of this disconnect means.

**Distributed Generator (DG):** Electric generation facilities connected to a Distribution System through a point of common coupling (PCC).

**Generator:** The generator could be a wind turbine, photovoltaic array, micro-generator, or fuel cell. These generators normally produce Direct Current (DC) power.

**Distribution Panel:** The distribution panel contains overcurrent devices and distributes electricity to the various electrical circuits and equipment in your home, farm or business. The distribution panel may be connected to both the LDC supply system and the Micro-embedded load displacement generation facility.

**Distribution System Code (DSC):** sets out the minimum conditions that an electricity distributor must meet in carrying out its obligations. All licensed electricity distributors in Ontario must comply with the provisions of the DSC as a condition of their license.

**Electricity Revenue Meter:** The Local Distribution Company supplies and installs the electricity meter that measures consumption of electrical energy supplied by the LDC to the customer.

**Electrical Wiring:** Electrical wiring, properly sized and installed to meet the requirements of the Electrical Safety Code connects these various pieces of electrical equipment together and allows the electricity to move through the electrical system. The electrical wiring is colour coded. The red, blue or black coloured conductor is the line or “hot” conductor. The white conductor is the neutral. The green coloured conductor is the bond conductor, or commonly referred to as the “ground” conductor.

**Embedded load displacement generation facility** means a generation facility connected on the customer side of the electricity meter and the customer generates power for their own use and not for the purpose of sale. These types of systems are intended to reduce the amount of electricity purchased from the local electrical utility, but they are not intended to provide surplus electricity into the utility’s electricity system.

**Micro-embedded load displacement generation facility** means an embedded load displacement generation facility that produces 10 kW of electricity or less.

**Inverter:** means a device that converts DC electricity into AC electricity Electrical equipment, appliances, tools, machines and lights connected to the wiring in your home, farm or business use alternating current (AC) power.

**Stand-Alone Inverter:** An inverter that operates only in stand-alone mode and thus contains no facility to synchronise its output energy from a Local Distribution Company.

**Grid Connected Inverter:** An inverter that is able to operate in grid parallel mode. Also known as a grid interconnect or a grid tie inverter.

**Grid Dependent Inverter:** An inverter that is able to operate in parallel to the distribution system and in order to operate there must be power available from the electric utility’s electricity grid. Loss of power from the grid will initiate a shutdown of the inverter to prevent islanding. Distributed generation systems using a grid dependent inverter will not provide back-up power during a utility power outage.

**Local Distribution Company (LDC):** The distribution of electricity to end use customers is carried out by Ontario's local electrical utilities or LDC’s. These utilities are responsible for maintaining their community's network of distribution wires. They also "step down" the voltage of electricity to make it safe for use by customers and provide electricity to end-users at market rates.

**Ontario Electrical Safety Code (OESC):** provides the standards for the safe installation of all temporary and permanent electrical wiring and equipment. The OESC applies to all homes, businesses, farms and industry in Ontario.

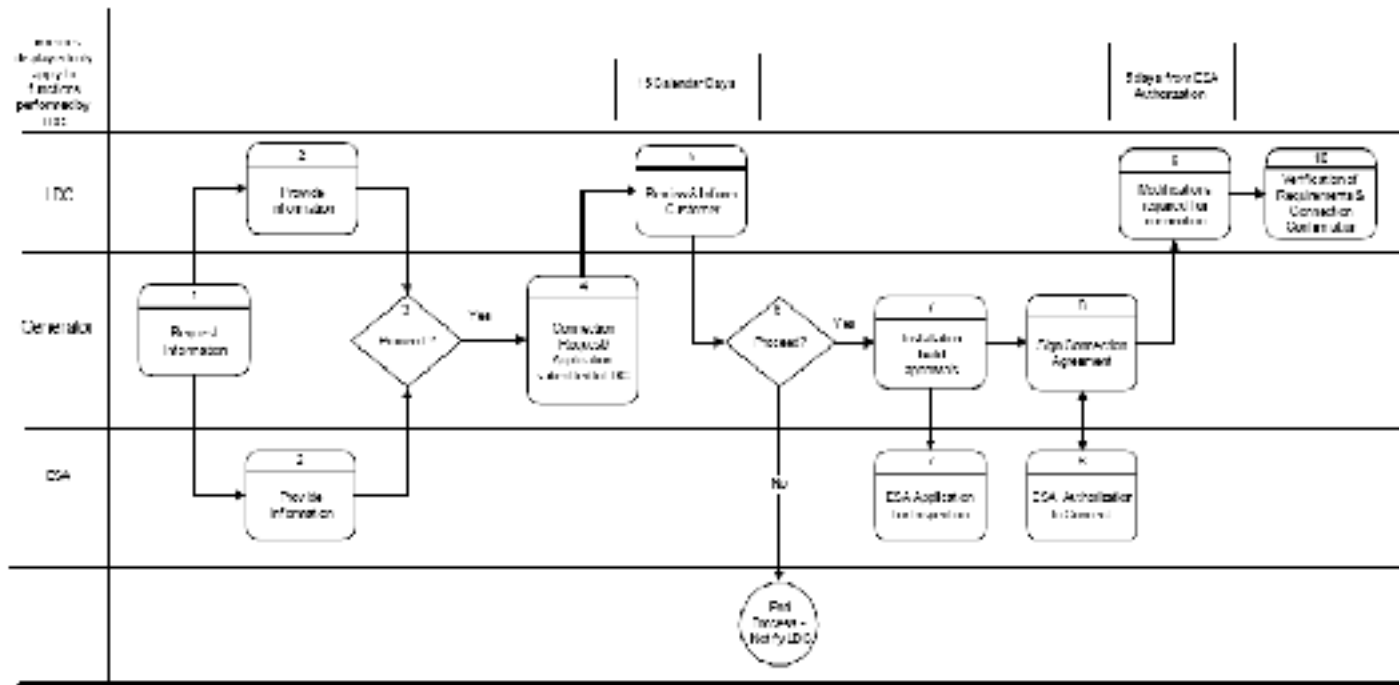
**Overcurrent Device:** A fuse or circuit breaker. An approved fuse or circuit breaker is required to protect people and the electrical system from a short circuit or overload failures. This is an important safety device.

## PLANNING AN INSTALLATION

Before you begin any installation work or make any commitments to purchase equipment or have equipment installed, it is very important that you do your homework first.

The Ontario Energy Board’s Distribution System Code (Appendix F) provides an outline for the micro-generation connection process, as follows.

### GENERATION CONNECTIONS MICRO ≤10 kW



(Source: OEB’s Process and Technical Requirements for Connecting Embedded Generation Facilities)

### 1. Request information from ESA and your Local Distribution Company.

## **2. Review these Electrical Safety Authority Guidelines.**

Be sure to review and understand the Electrical Safety Authority guidelines, including the requirements for electrical inspection and approval. If you are undertaking the electrical work yourself (not recommended) you will be required to submit an “Application for Inspection”.

### **Review the Local Distribution Company Information Package.**

The information package from the electric utility may include:

- A description of the connection process, timing and contact information.
- Approvals needed by the distributor for connection;
- Technical requirements including metering;
- Contractual requirements (Micro-Embedded Load Displacement Connection Agreement); and
- Application forms.

Some questions to consider when contacting the local electric utility are:

- Is a service upgrade required to accommodate the installation of an alternative generator?
- Is a utility disconnecting means required for isolation of generator?
- Where should the disconnecting means be located?
- Are there any other special technical requirements?
- Will the revenue meter need replacing?
- What are the charges for this connection?

### **Consult with one or more qualified electrical contractors.**

The Electrical Safety Authority recommends that all electrical work be done by a qualified electrical contractor/electrician. Installing an alternative generation system is beyond the ability of most do-it-yourself projects.

### **Check for any local bylaw or permit requirements.**

In addition to ensuring that you understand the electrical safety requirements you should also check with your local municipality, township or county about any bylaw or permit requirements that might apply depending on the type of installation.

## **3. After the above information has been gathered and reviewed, you make a decision whether to proceed further or not.**

#### **4. Complete and submit the necessary application to the LDC**

The application should include the following information:

- The name-plate rated capacity of each unit of the proposed generation facility and the total name-plate rated capacity of the proposed generation facility at the connection point;
- The fuel type of the proposed generation facility;
- The type of technology to be used; and
- The location of the proposed generation facility including address and account number with the distributor where available.

**5. After receiving and reviewing your application, and assuming that it meets the requirements, the local distribution company will confirm that the generator can be installed and connected.**

**6. After review and acceptance by the LDC, you again make a decision whether to proceed or not.**

#### **7. Proceeding With the Installation**

##### **i) Select Your Electrical Contractor.**

Prior to hiring an Electrical Contractor the Electrical Safety Authority recommends that you ensure that they:

- Hold a current certificate of qualification from the Ministry of Training, Colleges and Universities
- Have a Municipal business and/or contractors license (where required)
- Carry adequate liability insurance
- Can provide references
- Are prepared to take out the necessary “Application for Inspection”. If the person you are considering for the installation tells you that an electrical inspection is not required or suggests that you apply for the inspection on his or her behalf find someone else to do the work.
- Will provide a written estimate of the cost of the work.
- Ask about the amount of experience the electrical contractor/electrician has installing alternative generation systems. These systems are relatively new and not all electrical contractors/electricians have experience installing these types of systems.
- If the electrical contractor is providing the electrical equipment as part of the installation ensure that they are providing and installing approved equipment.
- Will provide you with a copy of the “Certificate of Inspection”. The Local Distribution Company will require a copy of the Certificate of Inspection before they will finalize the connection agreement with you. You may wish to hold back final payment until you this certificate.

## **ii) File a Completed Application for Inspection with the Electrical Safety Authority**

Before beginning the electrical work (or within 48 hours), your electrical contractor must file an application for inspection with the Electrical Safety Authority and pay the appropriate fees. For the installation of micro-generation systems the submission and approval of plans is not required. If you are doing the work yourself (not recommended) you are responsible for filing the application for inspection.

### **1-877-ESA-SAFE (1-877-372-7233)**

An Electrical Inspector will inspect the installation to determine if it meets the requirements of the OESC.

If the installation meets the safety requirements identified in the OESC, then a “Connection Authorization” will be issued to the LDC and a “Certificate of Inspection” will be provided to the electrical contractor. These documents provide assurance that the installation was inspected by ESA, was found in compliance with the requirements of the OESC, and may be connected and used.

## **8. Contact the Local Distribution Company and finalize the Connection Agreement**

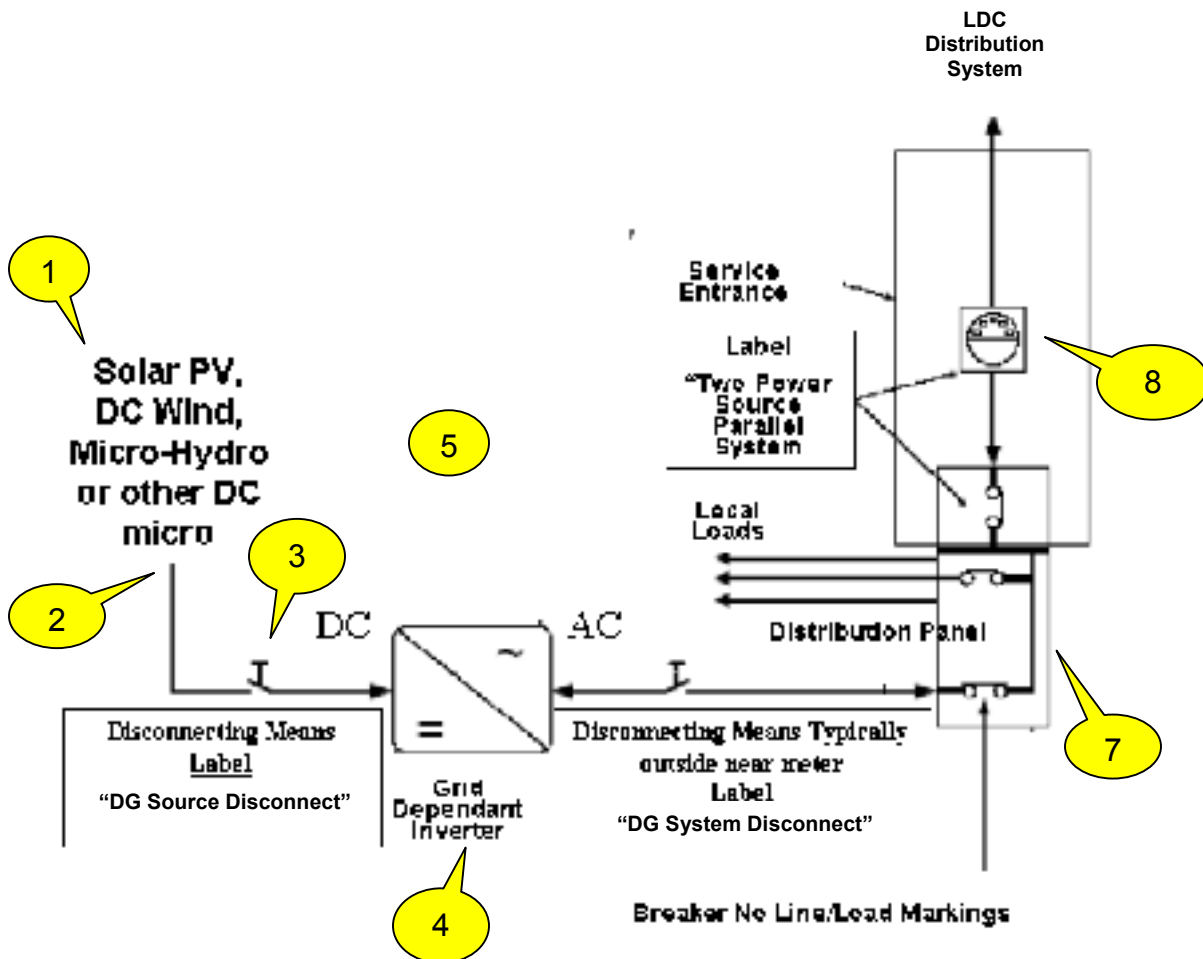
Following completion of the inspection(s) by the Electrical Safety Authority and the issuance of a certificate of inspection contact the local electric utility. Finalise the connection agreement and provide the LDC a copy the ESA certificate of inspection.

## **9. Local Distribution Company makes any modifications that may be required to the meter or electrical supply to your home, farm or business.**

## **10. Verification and completion.**

## **ELECTRICAL INSPECTION PROCESS**

Before the generator can be connected to the electrical system it must be inspected and approved by the Electrical Safety Authority. The OESC requires an Application for Inspection to be submitted by the contractor doing the electrical installation. The inspection provides assurance that the installation meets the safety requirements of the OESC and does not pose a hazard to you, your family, friends, or employees. It also provides an assurance that the installation will not pose a hazard to the local utility workers who may be required to service or repair the electrical supply to your farm, home or business.



With reference to the above diagram, the Inspector will look for the following requirements when inspecting the alternative generation installation.

### 1. Generator type and characteristics

The generator shall be approved for use in Canada, whether it is wind powered, photovoltaic, micro-hydro, etc. The inspector will look for a valid approval mark. The Inspector will also check the nameplate and note the generator electrical characteristics.

### 2. Overcurrent Device(s)

Where required by the OESC for protection of downstream conductors and equipment from overcurrent (short circuit or overload). The Inspector will check the rating and type for compliance with the OESC based on the generator nameplate ratings and the downstream conductors and equipment.

### **3. Disconnecting Means – Generator or Distributed Generation (DG) Source**

The disconnecting means must be approved for use in Canada. The inspector will look for a valid certification mark.

The disconnecting means shall be sized to safely handle the output of the generator unit. The OESC provides information on the sizing requirements and a qualified electrical contractor will be familiar with these. The disconnecting means shall have a label marked “DG SOURCE DISCONNECT”. The inspector will look for proper sizing, installation, and labelling.

Some Inverters units might have the disconnecting means built into the inverter unit. In that case the label “DG SOURCE DISCONNECT” will be on the inverter unit. If this is the case a separate disconnecting means is not required.

### **4. Grid Dependent Inverter**

An approved Grid Dependent Inverter is required. The inspector will look for a valid certification mark that indicates that the inverter meets the requirements of the Canadian Standards Association’s Standard C22.2 # 107.1 or the Underwriters Laboratory’s standard UL 1741.

The inverter shall also bear a label stating “UTILITY-INTERCONNECTED” indicating it meets the section of the standard for utility interconnected inverters.

As it is possible for electricity to flow to the inverter from both the generator and the distribution panel, the inverter shall also be marked “WARNING — POWER FED FROM MORE THAN ONE SOURCE”. This label serves as a warning and reminder to anyone that might service or repair the inverter to ensure the power to the inverter is disconnected from both the generator supply and from the distribution panel.

The inverter nameplate shall also contain the following information,

- Range of operating dc input current;
- Maximum output fault current; and
- Maximum utility back feed current

### **5. Wiring Methods**

Wiring shall be installed in accordance with requirements set out in Section 12 of the OESC.

### **6. Disconnecting Means — Distributed Generation (DG) System**

The inspector will verify that a second disconnect means (intended to protect utility workers) is installed in the location specified by the Local Distribution Company.

The inspector will verify that this disconnect is properly sized to handle the electrical output from the inverter and that it is wired so that it will simultaneously disconnect all ungrounded conductors of the distributed generator from the distribution supply system.

The inspector will verify that disconnect has a label marked “DG SYSTEM DISCONNECT”

## **7. Distribution Panel**

The circuit breaker in the distribution panel that connects to the distributed generation system shall not have any Line/Load markings. The Inspector will check to see that the circuit breaker is of adequate ampere and voltage rating and has an interrupt rating greater than the available fault current from the distribution system. The circuit breaker shall be clearly labelled to indicate its purpose. The main circuit breaker or disconnecting means for the distribution panel shall be labelled “WARNING – TWO POWER SOURCES – PARALLEL SYSTEM”.

## **8. Electricity Revenue Meter**

The electricity meter is the responsibility of the electrical utility and is installed to meet their requirements.

The inspector will verify that a label marked “WARNING – TWO POWER SOURCES – PARALLEL SYSTEM” is affixed in a location adjacent to the electricity meter. This label provides a warning to utility workers that your generator is capable of providing electricity into the utility system. It alerts them that they should disconnect the generator from the electrical supply system before beginning any work on the electrical system supplying your home, farm or business.

In addition to this warning label the inspector will verify that a single line diagram is posted at the electrical service. This single line diagram must be plainly and permanently marked, show the switching arrangements, the locations of the disconnects, and the location and type of generator.

## **OTHER SOURCES OF INFORMATION**

- Ontario Electrical Safety Code
- CSA C22.2 #107.1 General Use Power Supplies
- UL 1741 Inverters, Converters, and Controllers for Use in Independent Power Systems
- MicroPower Connect Interconnection Guidelines
- The Renewable Energy Handbook for Homeowners by William H. Kemp
- \$mart Power; an urban guide to renewable energy and efficiency The Renewable Energy Handbook for Homeowners by William H. Kemp
- Distribution System Code published by OEB



















- Standby Generators and Emergency Power Information By Ministry of Agriculture and Food
  - Generator Handbook
  - Generator fact sheets
  - [www.gov.on.ca/OMAFRA/english/engineer/generators](http://www.gov.on.ca/OMAFRA/english/engineer/generators)
- 
- Electricity Generation Using Small Wind Turbines At Your Home Or Farm, by S. Clarke of the Ministry of Agriculture

To file for an Application for Inspection call: **1-877-ESA-SAFE (372-7233)**

[www.esasafe.com](http://www.esasafe.com)

## Appendix A

Certification marks acceptable under the OESC of the Province of Ontario are,

<b>Canadian Standards Association (CSA)</b>	  			
<b>Entela</b>				
<b>Intertek Testing Services</b>				
<b>Met Laboratories Inc. (MET)</b>				
<b>OMNI Environmental Services Inc.</b>				
<b>Quality Auditing Institute</b>				
<b>QPS</b>				
<b>TUV America</b>				
<b>TUV Rheinland</b>				
<b>Underwriters Laboratories Inc. (UL)</b>				
<b>Underwriters' Laboratories of Canada (ULC)</b>	