



Runestone Electric Association

Distributed Generation Interconnection Requirements for Inverter Connected Systems Rated less than 40kW.

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1. Introduction

Electric distributed generation systems span a wide range of sizes and electrical characteristics. Electrical distribution system design varies widely from that required to serve the rural member to that needed to serve the large commercial member. With so many variations possible, it becomes complex and difficult to create one interconnection standard that fits all generation interconnection situations. This streamlined version of the Technical Requirements document has been written to only cover the technical interconnection requirements for generation systems utilizing a Grid Tie Inverter. If your system 1) is rated at 40kW or more; 2) does not qualify under PURPA rules and regulations; and 3) does not use a Grid Tie Inverter, then this document does not fully cover the Technical Requirements for interconnecting your system. Please refer to the "Runestone Electric Association Interconnection Requirements".

While, this standard provides the Technical Requirements for interconnecting a Generation System with a typical radial distribution system, it is important to note that there are some unique Area EPS, which have special interconnection needs. One example of a unique Area EPS would be one operated as a "networked" system. This standard does not cover the additional special requirements of those systems. The Interconnection Customer must contact the Owner/operator of the Area EPS with which the interconnection is intended, to make sure that the Generation System is not proposed to be interconnected with a unique Area EPS. If the planned interconnection is with a unique Area EPS, the Interconnection Customer must obtain the additional requirements for interconnecting with the distribution system.

Runestone Electric Association has the right to limit the maximum size of any Generation System or number of Generation Systems that may want to interconnect, if the Generation System would reduce the reliability to the other members connected to Runestone Electric's distribution system.

In creating this document many assumptions have been made about what is a "typical", less than 40kW Generation System. Due to these assumptions and the fact that there presently is not a standard for generation system design, there may be areas not covered within this document. In those cases the Runestone Electric Association's Distributed Generation Interconnection Standards will apply.

This standard only covers the technical requirements and does not cover the interconnection process from the planning of a project through approval and construction. Please read the companion document "Runestone Electric Association Interconnection Procedure for Inverter Connected Systems Rated less than 40kW" for the description of the procedure to follow and a generic version of the forms to submit. It is important to also get copies of Runestone Electric's tariff's concerning generation interconnection, which will include rates and costs. The earlier the Member gets the Runestone Electric Generation Interconnection Coordinator involved in the planning and design the smoother the process will go.

A) Definitions

The definitions defined in the "[IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems](#)" (IEEE 1547) apply to this document as well. The following definitions are in addition to the ones defined in IEEE 1547, or are repeated from the IEEE 1547 standard.

- i) "Area EPS" an electric power system (EPS) that serves Local EPS's. Note. Typically, an Area EPS has primary access to public rights-of-way, priority crossing of property boundaries, etc. Runestone Electric is an Area EPS.
- ii) "Generation" any device producing electrical energy, i.e., rotating generators driven by wind, steam turbines, internal combustion engines, hydraulic turbines, solar, fuel cells, etc.; or any other electric producing device, including energy storage technologies.
- iii) "Generation System" the interconnected Distributed Generation(s), controls, relays, switches, breakers, transformers, inverters and associated wiring and cables, up to the Point of Common Coupling.

- iv) “Grid Tie Inverter” The inverter is a device that converts DC electricity to AC electricity. While a Grid Tie Inverter also has been specially designed and constructed to safely interconnect with an Area EPS, for this document, a Grid Tie Inverter is also designed and tested to meet the requirements of IEEE 1547 and ANSI 929 standards and has been certified with a UL 1741 label.
- v) “Interconnection Customer” the party or parties who are responsible for meeting the requirements of this standard. This could be the Generation System applicant, installer, designer, owner or operator.
- vi) “Local EPS” an electric power system (EPS) contained entirely within a single premises or group of premises.
- vii) “Point of Common Coupling” the point where the Local EPS is connected to an Area EPS.
- viii) “Transmission System”, are those facilities as defined by using the guidelines established by the Minnesota State Public Utilities Commission; “In the Matter of Developing Statewide Jurisdictional Boundary Guidelines for Functionally Separating Interstate Transmission from Generation and Local Distribution Functions” Docket No. E-015/M-99-1002.
- ix) “Type-Certified” Generation paralleling equipment that is listed by an OSHA listed national testing laboratory as having met the applicable type testing requirement of UL 1741. At the time this document was prepared this was the only national standard available for certification of generation transfer switch equipment. This definition does not preclude other forms of type-certification if agreeable to Runestone Electric.

B) Interconnection Requirements Goals

This standard defines the minimum technical requirements for the implementation of the electrical interconnection between the Generation System and Runestone Electric’s distribution system. It does not define the overall requirements for the Generation System. The requirements in this standard are intended to achieve the following:

- i) Ensure the safety of utility personnel and contractors working on the electrical power system.
- ii) Ensure the safety of utility members and the general public.
- iii) Protect and minimize the possible damage to the electrical power system and other member’s property.
- iv) Ensure proper operation to minimize adverse operating conditions on the electrical power system.

C) Area EPS Modifications

Depending upon the size of the Generation System, the location on Runestone Electric’s distribution system and how the Generation System is operated, certain modifications and/or additions may be required to the existing Runestone Electric distribution system, with the addition of the Generation System. To the extent possible, this standard describes the modifications, which could be necessary to Runestone Electric’s distribution system for different types of Generation Systems. If any special requirements are necessary they will be identified by Runestone Electric during the application review process.

D) Generation System Protection

The Interconnection Customer is solely responsible for providing protection for the Generation System. Protection systems required in this standard, are structured to protect Runestone Electric’s distribution system and the public. The Generation System protection is not provided for in this standard. Additional protection equipment may be required to ensure proper operation for the Generation System. This is especially true while operating disconnected, from Runestone Electric’s distribution system. Runestone Electric’s distribution system does not assume responsibility for protection of the Generation System equipment or of any portion of the Local

EPS.

E) Electrical Code Compliance

The Interconnection Customer shall be responsible for complying with all applicable local, independent, state and federal codes such as building codes, National Electric Code (NEC), National Electrical Safety Code (NESC) and noise and emissions standards. As required by Minnesota State law, Runestone Electric's distribution system will require proof of complying with the National Electrical Code before the interconnection is made, through installation approval by an electrical inspector recognized by the Minnesota State Board of Electricity.

The Interconnection Customer's Generation System and installation shall comply with latest revisions of the ANSI/IEEE standards applicable to the installation, especially IEEE 1547; "Standard for Interconnecting Distributed Resources with Electric Power Systems". See the reference section in this document for a partial list of the standards, which apply to the generation installations covered by this standard.

2. References

The following standards shall be used in conjunction with this standard. When the stated version of the following standards is superseded by an approved revision then that revision shall apply.

IEEE Std 100-2000, "IEEE Standard Dictionary of Electrical and Electronic Terms"

IEEE Std 519-1992, "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems"

IEEE Std 929-2000, "IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems".

IEEE Std 1547, "IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems"

IEEE Std C37.90.1-1989 (1995), "IEEE Standard Surge Withstand Capability (SEC) Tests for Protective Relays and Relay Systems".

IEEE Std C37.90.2 (1995), "IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers".

IEEE Std C62.41.2-2002, "IEEE Recommended Practice on Characterization of Surges in Low Voltage (1000V and Less) AC Power Circuits"

IEEE Std C62.42-1992 (2002), "IEEE Recommended Practice on Surge Testing for Equipment Connected to Low Voltage (1000V and less) AC Power Circuits"

ANSI C84.1-1995, "Electric Power Systems and Equipment – Voltage Ratings (60 Hertz)"

ANSI/IEEE 446-1995, "Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications".

ANSI/IEEE Standard 142-1991, "IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems – Green Book",

UL Std. 1741 "Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources"

NEC – "National Electrical Code", National Fire Protection Association (NFPA), NFPA-70-2002.

NESC – "National Electrical Safety Code". ANSI C2-2000, Published by the Institute of Electrical and Electronics Engineers, Inc.

3. Interconnection Issues and Technical Requirements

A) General Requirements - The following requirements apply to the interconnected generating equipment. Runestone Electric's distribution system shall be considered the source side and the member's system shall be considered the load side in the following interconnection requirements.

- i) For three-phase operation, the inverter control must also be able to detect and separate for the loss of one phase.
- ii) If banks of inverter systems are installed at one location, a design review by Runestone Electric must be performed to determine if there are any additional protection systems, metering or other needs. The issues will be identified by Runestone Electric once the interconnection application is received.
- iii) Visible Disconnect – A visible disconnect is required for safely isolating the Distributed Generation when connecting with an inverter. The inverter shall not be used as a safety isolation device. A disconnecting means shall be installed to electrically isolate the Inverter from the rest of the load. The visible disconnect shall provide a visible air gap between Interconnection Customer's Generation and Runestone Electric's distribution system in order to establish the safety isolation required for work on Runestone Electric's distribution system. This disconnecting means shall be readily accessible and within sight of the Service Point as defined by the NEC. The disconnecting means must be available 24 hours per day by Runestone Electric field personnel and shall be capable of padlocking by Runestone Electric field personnel. The disconnecting device shall be lockable in the open position.

The visible disconnect shall be a UL approved or National Electrical Manufacture's Association approved, manual safety disconnect switch of adequate ampere capacity. The visible disconnect shall not open the neutral when the switch is open.

The visible disconnect shall be labeled, as required by Runestone Electric, to inform the Runestone Electric field personnel.

- iv) Energization of Equipment by Generation System – The Generation System shall not energize any de-energized portion of Runestone Electric's distribution system.
- v) Fault and Line Clearing - The Generation System shall be removed from Runestone Electric's distribution system for any faults, or outages occurring on the electrical circuit serving the Generation System.
- vi) Interference - The Interconnection Customer shall disconnect the Distributed Generation from Runestone Electric's distribution system if the Distributed Generation causes radio, television or electrical service interference to other members, via the EPS or interference with the operation of Area EPS. The Interconnection Customer shall either effect repairs to the Generation System or reimburse Runestone Electric for the cost of any required modifications to Runestone Electric's distribution system due to the interference.
- vii) Unintended Islanding – Under certain conditions with extended parallel operation, it would be possible for a part of Runestone Electric's distribution system to be disconnected from the rest of Runestone Electric's distribution system and have the Generation System continue to operate and provide power to a portion of the isolated circuit. This condition is called "islanding". It is not possible to successfully reconnect the energized isolated circuit to the rest of Runestone Electric's distribution system since there are no synchronizing controls associated with all of the possible locations of disconnection. Therefore, it is a requirement that the Generation System be automatically disconnected from Runestone Electric's distribution system immediately by protective relays for any condition that would cause Runestone Electric's distribution system to be de-energized. The Generation System must either isolate with the member's load or trip. The Generation System must also be blocked from closing back into Runestone Electric's distribution system until Runestone Electric's

distribution system is reenergized and Runestone Electric's distribution system voltage is within Range B of ANSI C84.1 Table 1 for a minimum of 1 minute. Depending upon the size of the Generation System it may be necessary to install direct transfer trip equipment from Runestone Electric's distribution system source(s) to remotely trip the generation interconnection to prevent islanding for certain conditions

viii) Protective Systems. In general a Grid Tie Inverter is designed, constructed and tested so that the necessary protective functions are built in to the inverter, to ensure isolation of the generation system from the distribution system as required. In general, the functions required by IEEE 1547 and IEEE 929 standards, include Over/Under Voltage, Over/Under Frequency, phase and ground overcurrent. So, no further protective equipment is typically necessary. Please note that the NEC or other state or local codes may require you to install additional protective equipment such as fuses.

ix) Disconnection – Runestone Electric's distribution system operator may refuse to connect or may disconnect without prior notice, a Generation System from Runestone Electric's distribution system under the following conditions:

- (1) Lack of approved Standard Application Form and Standard Interconnection Agreement.
- (2) Termination of interconnection by mutual agreement.
- (3) Non-Compliance with the technical or contractual requirements.
- (4) System Emergency or for imminent danger to the public or Runestone Electric personnel (Safety).
- (5) Routine maintenance, repairs and modifications to Runestone Electric's distribution system. Runestone Electric shall coordinate planned outages with the Interconnection Customer to the extent possible.

4. Generation Metering, Monitoring and Control

Metering, Monitoring and Control – For distributed generation systems less than 40kW the following are the Metering, Monitoring and Control requirements. This document assumes that the Generation System qualifies under the PURPA requirements (Public Utilities Regulatory Power Act – Federal Gov. 1978), and the power is not being sold to a third party.

Metering Requirements*

For Generation Systems that qualify under the PURPA requirements, the service will be metered following the State of Minnesota net metering standards.

- For single-phase Generation Systems the applicant is required to provide and install a Runestone Electric approved single phase meter socket. Runestone Electric will supply a single-phase meter that will record power flow in both directions.
- For three-phase Generation Systems the applicant is required to provide a Runestone Electric approved commercial three phase meter socket. Runestone Electric will supply the three-phase meter to record power flow in both directions.

Monitoring and Control Requirements *

For qualified inverter connected Generation Systems 40kW and less there are no requirements for monitoring and remote control of the generation system by Runestone Electric.

* The above Metering, Monitoring and Control Requirements assume a typical installation. There could be other requirements for metering, monitoring or control that are required under special tariffs.

5. Agreements

A) Uniform Statewide Contract for Cogeneration or Small Power Production Facilities – This agreement is a standard contract between the Applicant and Runestone Electric. A copy of this State of Minnesota mandated standard agreement is attached.

6. Testing Requirements

A) Certification of equipment

The most important part of the process to interconnect generation with Local and Area EPS's is safety. One of the key components of ensuring the safety of the public and employees is to ensure that the design and implementation of the elements connected to the electrical power system operate as required. To meet this goal, all of the electrical wiring in a business or residence, is required by the State of Minnesota to be listed by a recognized testing and certification laboratory, for its intended purpose. Typically we see this as "UL" listed. To be able to follow this version of the Technical Standard the Inverter used, shall be listed by a nationally recognized testing laboratory as having met the applicable type-testing requirements of UL 1741 and IEEE 929, shall be acceptable for interconnection without additional protection system requirements.

B) Commissioning Testing

The following tests shall be completed by the Interconnection Customer. Runestone Electric has the right to witness all field testing and to review all records prior to allowing the system to be made ready for normal operation.

- i) Before testing - The Generation System shall be inspected and approved by the State of Minnesota Electrical Inspector prior to interconnecting the Generation System with the electrical system.
- ii) Any pre-testing recommended by the equipment manufacture and/or installer shall be completed prior to the On-line Commissioning test.
- iii) On-Line Commissioning Test – Runestone Electric and the Generation System owner shall complete the following tests once the Generation System has completed Pre-testing and the results have been reviewed and approved by Runestone Electric. Generation System functionally shall be verified for specific interconnections as follows:

(1) Anti-Islanding Test Steps

- (a) The Generation System shall be started and operated in parallel with Runestone Electric's distribution system source.
- (b) Runestone Electric's distribution system source shall be removed by opening a switch, fuse or breaker or other means on the Runestone Electric side of the inverter.
- (c) Under the condition established in step b, the Generation System shall stop generating.
- (d) Under the condition established in step b, the Generation System shall not reenergize any part of the Utilities distribution system (Area EPS).
- (e) The device that was opened to disconnect Runestone Electric's distribution system source shall be closed and the Generation System shall not re-parallel / reconnect with Runestone Electric's distribution system for at least 5 minutes or other agreed to duration.
- (f) For three phase systems this test will be repeated for each phase of the system and also for a complete three phase loss of Utility power.

iv) Periodic Testing and Record Keeping

- v) Any time the inverter hardware or software, is replaced and/or modified, Runestone Electric Generation Coordinator shall be notified. This notification shall be as soon as reasonable possible and, if possible, be with sufficient warning so that Runestone Electric personnel can be involved and/or witness the verification testing. Verification testing shall be completed on the replaced and/or modified equipment and systems. The involvement of Runestone Electric

personnel will depend upon the complexity of the Generation System and the component being replaced and/or modified. Since the Interconnection Customer and Runestone Electric are now operating an interconnected system. It is important for each to communicate changes in operation, procedures and/or equipment to ensure the safety and reliability of the Local and Area EPS.

- (1) All interconnection-related protection systems shall be periodically tested and maintained, by the Interconnection Customer, at intervals specified by the manufacture or system integrator. These intervals shall not exceed 5 years. Periodic test reports and a log of inspections shall be maintained, by the Interconnection Customer and made available to Runestone Electric upon request.

