

Agralite Electric Cooperative

Requirements: Eligible DG Systems Rated Less Than 40 kW

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I. Introduction

Electric distributed generation systems span a wide range of sizes and electrical characteristics. Electrical distribution system design varies widely from what is required to serve the rural Member to what is required 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 which meet all of the criteria outlined in the definition of an Eligible DG System Rated Less Than 40 kW. If your system 1) is rated at 40 kW or more; 2) does not qualify under PURPA rules and regulations; or 3) does not use a Grid Tie Inverter or an Interconnection Relay, then this document does not fully cover the Technical Requirements for interconnecting your system. If that is the case please refer to the Agralite document titled "Requirements: DG Systems."

Agralite Electric Cooperative has the right to limit the maximum size of a Distributed Generation (DG) System or the number of DG Systems that are allowed to interconnect if the DG System would reduce reliability to other Members connected to Agralite's Distribution System.

In creating this document many assumptions have been made about what is a "typical," less than 40kW DG System. Due to these assumptions and the fact that presently there is not a standard for generation system design, there may be areas not covered within this document. In those cases the Agralite document titled "Requirements: DG Systems" shall 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 refer to the companion document "Procedure: Eligible DG Systems Rated Less than 40 kW" for the process to follow. It is also important to get copies of Agralite's tariffs concerning generation interconnection, which will include rates and costs. The earlier the Member contacts Agralite's DG Coordinator and involves him or her in the planning and design the smoother the process will go.

This Agralite document ("Requirements: Eligible DG Systems Rated Less Than 40 kW") and Agralite's full version of this document ("Requirements: DG Systems") are based on and incorporate all the requirements found in the state document titled "State of Minnesota Distributed Generation Interconnection Requirements." Items in this document preceded by "[AEC]" indicate that the requirement or standard is specific to Agralite Electric Cooperative and is supplemental to the requirements or standards found in the state document ("State of Minnesota Distributed Generation Interconnection Requirements").

II. General Information

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.

1. [AEC] Applicant (or Member) is defined as the person or entity, whom is requesting the interconnection of the Generation System with Agralite and has overall responsibility for ensuring that the Generation System is designed, operated and maintained in compliance with the Technical Requirements.
2. "Area EPS" is 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. Agralite is an Area EPS.
3. [AEC] Cooperative – Agralite Electric Cooperative (Agralite)
4. [AEC] Distributed Generation (DG) for this document is defined as generation typically built within close proximity to the generating Member's load where the primary purpose of the generation is to offset energy use. DG includes, but may not be limited to the following:
 - a. small scale generators such as photovoltaic (PV), fuel cells, small wind turbines;
 - b. micro-turbines or reciprocating engines fueled by renewable fuels such as landfill gas or methane gas from digesters;
 - c. any qualifying facility (QF) under the Public Utility Regulatory Policies Act of 1978 (PURPA)
5. [AEC] DG Coordinator the person or persons designated by Agralite to provide a single point of coordination with the Member for the generation interconnection process.
6. [AEC] Distribution System is the Agralite facilities which are not part of the Area EPS Transmission System or any Generation System.
1. Eligible DG System Rated Less Than 40 kW – For this document a DG System shall meet all of the following criteria and requirements in order to be considered an Eligible DG System Rated Less Than 40 kW.
 - a. Qualifies under PURPA rules and regulations as a Qualifying Facility
 - b. Total Nameplate Capacity is less than 40 kW
 - a. Protection scheme utilizes a Grid Tie Inverter or an Interconnection Relay
7. Generation is 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.
8. Generation System is the interconnected generator(s), controls, relays, switches, breakers, transformers, inverters and associated wiring and cables, up to the Point of Common Coupling.
9. Grid Tie Inverter is a device that converts DC electricity to AC electricity and 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.

10. Interconnection Customer is the party or parties who will own/operate the Generation System and are responsible for meeting the requirements of the Agreements and Technical Requirements. This could be the Generation System applicant, installer, owner, designer, or operator.
11. [AEC] Interconnection Relay is a protection device that detects Area EPS supply problems and automatically disconnects the DG System from the Area EPS. For this document, an Interconnection Relay is also designed and tested to meet the requirements of IEEE 1547.
12. Local EPS is an electric power system (EPS) contained entirely within a single premises or group of premises.
13. Point of Common Coupling is the point where the Local EPS is connected to an Area EPS.
14. [AEC] Public Utilities Regulatory Policies Act – 1978 (PURPA) is a US federal law enacted in 1978 which was intended to encourage more energy-efficient and environmentally friendly commercial energy production. PURPA defined a new class of energy producer called a Qualifying Facility.
15. [AEC] Qualifying Facilities (QFs) are either small-scale producers of commercial energy who normally self-generate energy for their own needs but may have occasional or frequent surplus energy, or incidental producers who happen to generate usable electric energy as a byproduct of other activities. A Qualifying Facility satisfies the conditions established in Code of Federal Regulations, title 18, section 292.101(b)(1), (1981), as applied when interpreted in accordance with the amendments to Code of Federal Regulations, title 18, sections 292.201 to 292.207 adopted through Federal Register, volume 46, pages 33025-33027, (1981).
16. [AEC] Technical Requirements refers to the set of requirements outlined in the Agralite document titled “Requirements: DG Systems.” This Requirements document is a more concise subset of the Technical Requirements. Both of the documents are based on and incorporate all the requirements found in the state document titled “State of Minnesota Distributed Generation Interconnection Requirements.”
17. 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.
18. Type-Certified is generation paralleling equipment that is listed by an OSHA listed national testing laboratory as having met the applicable type testing requirement of UL 1741 or UL Subject 6140. At the time this document was prepared these were the only national standards available for certification of generation transfer switch equipment. This definition does not preclude other forms of type-certification if agreeable to Agralite.

B. Interconnection Requirements Goals

This standard defines the minimum technical requirements for the implementation of the electrical interconnection between the DG System and Agralite’s Distribution System. It does not define the

overall requirements for the DG System. The requirements in this standard are intended to achieve the following:

1. Ensure the safety of Agralite personnel and contractors working on the electrical power system.
2. Ensure the safety of Agralite Members and the general public.
3. Protect and minimize the possible damage to the electrical power system and Member's property.
4. Ensure proper operation to minimize adverse operating conditions on the electrical power system.

C. Area EPS Modifications

Depending on the size of the DG System, the location on Agralite's Distribution System and how the DG System is operated, certain modifications and/or additions may be required to Agralite's existing Distribution System. To the extent possible, this standard describes the modifications, which could be necessary to Agralite's Distribution System for different types of DG Systems. If any special requirements are necessary they will be identified by Agralite during the application review process.

D. Generation System Protection

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

E. Electrical Code Compliance

1. 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, Agralite's Distribution System will require proof of complying with the National Electrical Code before the interconnection is made. This will be accomplished through final inspection and approval by a Minnesota State Electrical Inspector.
2. The Interconnection Customer's DG System and installation shall comply with latest revisions of the ANSI/IEEE standards applicable to the installation. One such standard is 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.

F. 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.

1. IEEE Std 100-2000, "IEEE Standard Dictionary of Electrical and Electronic Terms"
2. IEEE Std 519-1992, "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems"
3. IEEE Std 929-2000, "IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems".
4. IEEE Std 1547, "IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems"
5. IEEE Std C37.90.1-1989 (1995), "IEEE Standard Surge Withstand Capability (SEC) Tests for Protective Relays and Relay Systems".
6. IEEE Std C37.90.2 (1995), "IEEE Standard Withstand Capability of Relay Systems to Radiated
7. Electromagnetic Interference from Transceivers".
8. IEEE Std C62.41.2-2002, "IEEE Recommended Practice on Characterization of Surges in Low Voltage (1000V and Less) AC Power Circuits"
9. IEEE Std C62.42-1992 (2002), "IEEE Recommended Practice on Surge Testing for Equipment Connected to Low Voltage (1000V and less) AC Power Circuits"
10. ANSI C84.1-1995, "Electric Power Systems and Equipment – Voltage Ratings (60 Hertz)"
11. ANSI/IEEE 446-1995, "Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications".
12. ANSI/IEEE Standard 142-1991, "IEEE Recommended Practice for Grounding of Industrial an
13. 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"
14. NEC – "National Electrical Code", National Fire Protection Association (NFPA), NFPA-70-2002.
15. NESC – "National Electrical Safety Code". ANSI C2-2000, Published by the Institute of Electrical and Electronics Engineers, Inc.

III. Interconnection Issues and Technical Requirements

A. General Requirements

The following requirements apply to the interconnected generating equipment. Agralite's Distribution System shall be considered the source side and the Member's Generation System shall be considered the load side in the following interconnection requirements.

1. For three-phase operation, the inverter or relay control must be able to detect and separate for the loss of one or more phases.
2. If banks of inverter or relay systems are installed at one location, a design review by Agralite must be performed to determine if there are any additional protection systems, metering or other needs that are required. The issues will be identified by Agralite once the interconnection application is received.
3. Visible Disconnect-
 - a. A visible disconnect is required for safely isolating the Distributed Generation. The inverter or relay shall not be used as a safety isolation device. The visible disconnect shall be installed to electrically isolate and provide a visible air gap between the Interconnection Customer's Generation and Agralite's Distribution System in order to establish the safety isolation required for work on Agralite's Distribution System. This disconnecting device shall be readily accessible 24 hours per day by Agralite field personnel and shall be capable of padlocking by Agralite field personnel. The disconnecting device shall be lockable in the open position.
 - b. 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.
 - c. The visible disconnect shall be labeled, as required by Agralite, to inform the Agralite field personnel.
 - d. [AEC] The visible disconnect shall be located within eight feet of the main meter.
4. [AEC] Distribution System Open Point - If not already in place, Agralite may install a cabinet or cutout(s) up-line (source side) of the service transformer(s) in order to provide a visual open/isolation point on the Distribution System. The cabinet or cutout(s) will be installed at a location on the Distribution System such that the Member's DG System and the transformer(s) feeding the DG System can be manually isolated from the rest of the Distribution System and not affect service to other Cooperative Members. This is in addition to the Visible Disconnect requirement as explained above.
5. Energization of Equipment by the Generation System - The DG System shall not energize any de-energized portion of Agralite's Distribution System.
6. Power Factor - The power factor of the DG System and connected load shall be no less than 90% at the PCC.
 - a. [AEC] If power factor levels are outside the limits identified above, Agralite reserves the right to require the Member to install power factor correction equipment or reimburse the Cooperative for its cost of installing power factor correction equipment.

7. [AEC] Single Phase Limitations - The total Nameplate Capacity shall be limited to 10 kW and below for single-phase DG Systems operating in parallel with the Agralite's Distribution System unless authorized by the Cooperative. Single-phase installations greater than 10 kW may be permitted if engineering calculations determine that the installation will not adversely affect adjacent Agralite Members.
8. Fault and Line Clearing - The DG System shall be removed from Agralite's Distribution System for any faults or outages occurring on the electrical circuit serving the DG System.
9. Interference - The Interconnection Customer shall disconnect the DG System from Agralite's Distribution System if the DG System causes radio, television or electrical service interference to other Members via the EPS or interference with the operation of the Area EPS. The Interconnection Customer shall either effect repairs to the DG System or reimburse Agralite for the cost of any required modifications to Agralite's Distribution System due to the interference.
10. Unintended Islanding - Under certain conditions with extended parallel operation, it would be possible for a part of Agralite's Distribution System to be disconnected from the rest of Agralite's Distribution System and have the DG 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 Agralite'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 DG System be automatically disconnected from Agralite's Distribution System immediately by protective relays for any condition that would cause Agralite's Distribution System to be de-energized. The DG System must either isolate with the Member's load or trip. The Generation System must also be blocked from closing back into Agralite's Distribution System until Agralite's Distribution System is reenergized and Agralite's Distribution System voltage is within Range B of ANSI C84.1 Table 1 for a minimum of 5 minutes. Depending upon the size of the DG System it may be necessary to install direct transfer trip equipment from Agralite's Distribution System source(s) to remotely trip the generation interconnection to prevent islanding for certain conditions.
11. Protective Systems –
 - a. 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 DG 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, and phase and ground over-current. 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.
 - b. An Interconnection Relay is constructed and tested to ensure isolation of the DG System from the Distribution System as required. In general, the functions required by IEEE 1547 include: Over/Under Voltage, Over/Under Frequency, and phase and ground over-current. 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.

12. [AEC] Interconnection - Interconnection of a DG System with Agralite's Distribution System shall only be permitted after all requirements are met and written authorization to interconnect is issued by the Cooperative.
13. Disconnection- Agralite may refuse to connect or may disconnect without prior notice, a DG System from Agralite's Distribution System under the following conditions:
 - a. There is not an approved Application Form and/or the Interconnection Agreement is not in place.
 - b. [AEC] There is no proof of insurance or the level and/or type of insurance is not consistent with that described in Section V.
 - c. Termination of interconnection by mutual agreement.
 - d. Non-Compliance with any of the technical or contractual requirements.
 - e. [AEC] DG System output exceeds 40 kW.
 - f. System Emergency or for imminent danger to the public or Agralite personnel (Safety).
 - g. Routine maintenance, testing, repairs and modifications to Agralite's Distribution System. Agralite shall coordinate planned outages with the Interconnection Customer to the extent possible.

IV. Generation Metering, Monitoring and Control

A. 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 DG System qualifies under the PURPA requirements (Public Utilities Regulatory Policies Act – Federal Gov. 1978) and the power is not being sold to a third party.

1. Metering Requirements*- For DG Systems that qualify under the PURPA requirements, the service will be metered following the State of Minnesota net metering standards.
 - a. For single-phase DG Systems the Member is required to provide and install an Agralite approved single phase meter socket. Agralite will supply a single-phase meter that will record power flow in both directions. The Member shall be responsible for the cost of the meter and the meter socket.
 - b. For three-phase Generation Systems the Member is required to provide an Agralite approved commercial three phase meter socket. Agralite will supply the three-phase meter to record power flow in both directions. The Member shall be responsible for the cost of the meter and the meter socket.
2. Monitoring and Control Requirements*- For qualified DG Systems 40 kW and less there are no requirements for monitoring and remote control of the DG System by Agralite.
3. [AEC] Agralite shall retain the right to install additional metering equipment for data collection and research purposes. Agralite will furnish such metering equipment and pay all associated operation and maintenance costs.

4. [AEC] Load management sub-meters are not compatible with typical DG Systems. Agralite may remove existing sub-meters when DG Systems are installed and interconnected. Agralite may allow, at the Member's expense, load management meters which are connected on the utility side of the main meter.

* The above Metering, Monitoring and Control Requirements assume a typical installation. There could be other requirements for metering, monitoring or control that are required for "non-typical" installations.

V. Contracts / Agreements / Insurance

A. Contracts / Agreements

1. Statewide Contract for Cogeneration and Small Power Production Facilities Having Less Than 40 Kilowatts of Capacity- This agreement is a standard contract between the Member and Agralite.
2. [AEC] The State of Minnesota mandated standard agreement ("Uniform Statewide Contract for Cogeneration and Small Power Production Facilities Having Less Than 40 Kilowatts of Capacity") may also be referenced as the Agralite document titled "Schedule D: DG Interconnection Agreement for Systems Rated Less than 40 kW." This Agreement is available from Agralite's DG Coordinator.
3. [AEC] Any individual, corporation, or partnership wishing to interconnect with Agralite's Distribution System shall become a Member of Agralite Electric Cooperative. Correspondence and actions pertaining to application submittal and signing, agreement signing, payments and billing and all other required dealings will be done between the Member and Agralite only.

B. Insurance

1. [AEC] In connection with the performance of their duties and obligations, the Interconnection Customer shall maintain, during the term of the Interconnection Agreement, general liability insurance, from a qualified insurance agency with a B+ or better rating by "Best" and with a combined single limit of not less than three hundred thousand (\$300,000) for each occurrence if the Nameplate Capacity of the Generation System is less than 40 kW.

VI. 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 this is seen as "UL" listed. To be in compliance with this version of the Technical Requirements a Grid Tie Inverter shall be listed by a nationally recognized testing laboratory as having met the applicable type-testing requirements of UL 1741 and IEEE 929. [AEC] If an Interconnection Relay is used it shall be listed by a nationally recognized testing laboratory and meet the applicable type-testing requirements of IEEE 1547.

B. Commissioning Testing

The following tests shall be completed by the Interconnection Customer. Agralite 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.

1. Before testing- The DG System shall be inspected and approved by a State of Minnesota Electrical Inspector prior to interconnecting the DG System with Agralite's Distribution System.
2. Any pre-testing recommended by the equipment manufacturer and/or installer shall be completed prior to the On-line Commissioning test.
3. On-Line Commissioning Test – Agralite and the Interconnection Customer shall complete an on-line commissioning test (anti-island test) in order to verify functionality once the DG System has completed pre-testing and the results have been reviewed and approved by Agralite. Agralite's Distribution System shall be considered the source side and the Member's Generation System shall be considered the load side in the following steps.
 - a. [AEC] Anti-Island Test Steps
 - 1) The DG System shall be started and operated in parallel with Agralite's Distribution System source.
 - 2) Agralite's Distribution System source shall be removed by opening a switch, fuse or breaker or by other means deemed acceptable by Agralite on the source side of the Grid Tie Inverter or Interconnection Relay.
 - 3) Under the condition established in Step 2, the DG System shall immediately stop generating. Voltage measurements shall be taken on either the load side or the source side of the transformer(s) to ensure generation has ceased.
 - a) Applicable voltage(s) measured on the load side or the source side of the transformer(s) shall be zero when simulating a single-phase or a three-phase outage. The accuracy of the meter and special characteristics of the service shall be taken into account when determining whether or not the measured voltage is considered zero.
 - 4) Under the condition established in Step 2, the DG System shall not reenergize any part of Agralite's Distribution System.
 - 5) The device that was opened to disconnect Agralite's Distribution System source shall be closed and the DG System shall not automatically reparallel / reconnect with Agralite's Distribution System for at least 5 minutes.
 - 6) For three-phase systems this test will be repeated for each phase of the system and also for a complete three phase loss of Agralite's Distribution System source.

C. Periodic Testing and Record Keeping

1. Anytime the Grid Tie Inverter or Interconnection Relay hardware or software is replaced and/or modified, Agralite's DG Coordinator shall be notified. This notification shall be as soon as reasonably possible and be with sufficient warning so that Agralite 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 Agralite personnel will depend upon the complexity of the DG System and the component being replaced and/or modified. Since the Interconnection Customer and Agralite are now operating an interconnected system it is important for each to communicate changes in operation, procedures and equipment to ensure the safety and reliability of the Local and Area EPS.
2. 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 Agralite upon request.
3. [AEC] All interconnection related protection systems may be periodically tested by Agralite personnel in order to verify correct operation. The testing will be performed according to the steps outlined previously for conducting an anti-island test. Agralite shall coordinate such testing with the Interconnection Customer.





