



FIRELANDS ELECTRIC COOPERATIVE, INC.

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TECHNICAL REQUIREMENTS

FOR INTERCONNECTION AND PARALLEL OPERATION OF DER SYSTEMS

APPLICATIONS

Regulations established by Firelands Electric Cooperative Inc (the Cooperative) apply to interconnection and parallel operation of DER (Distributed Energy Resource) equipment that is rated not more than 25kW in the aggregate, of which the output is not reasonably anticipated to exceed the annual electric requirements of the consumer's electric consuming facilities located on the premises, with said DER equipment intending to operate on the Cooperative's (up to) 12.47 kV three phase and/or 7.2 kV single phase distribution lines. DER interconnections not meeting the Applications, Design Requirements and Operating Procedures contained within these requirements are prohibited. The cooperative reserves the right to modify these regulations at their discretion and without prior notice.

DEFINITIONS

- 1.1 Distributed Resource (DER)/DER Facility – Any source of electric power that is not directly connected to the bulk power transmission system, having an installed capacity of not more than 25 kW in the aggregate connected to the Cooperative's electric power system through a point of common coupling, including both generators and energy storage technologies, including any qualifying cogeneration or small power production facility meeting all definitional requirements under the Public Utility Regulatory Policies Act of 1978, as amended, and all governmental regulations lawfully promulgated thereunder (Qualifying Facility), as well as any Permitted Synchronized Generation Facilities.
- 1.2 Flicker – A variation of input voltage sufficient in magnitude and duration to allow visual observation of a change in electric lighting source intensity, as defined in IEEE Standard 141-1993. See Also Exhibit 1, attached, specifically the curve "Border Line of Visibility".
- 1.3 Facilities Study – An engineering study conducted to determine the modifications to the existing cooperative system that will be needed to accommodate connections and safe operation of the DER Facility.
- 1.4 Harmonic Distortion – Distortion of the normal sine waveform; typically caused by nonlinear loads or by inverters attached to the system on consumer's premises.
- 1.5 Interconnection Agreement – A legal contract for the connection of the DER Facility to the Cooperative's lines, specifying the location, size, cost, manner of payment, terms of operation, and respective responsibilities of the Cooperative and the DER Facility owner.
- 1.6 Permitted Synchronized Generation Facilities – Electric generation facilities not more than 25 kW in the aggregate, other than Qualifying Facilities, owned or operated by manufacturers and similar large commercial and industrial electric power and energy consumers in parallel operation with adjacent electric distribution facilities of the Cooperative under circumstances where (A) such generation facilities are operated for the sole purpose of (1) providing back-up generation when it is anticipated that there is a possibility of interruption of generation service provided by the Cooperative, or (2) minimizing or eliminating the consumer's contribution to a PJM 5-CP System Annual Demand, or (3) testing the consumer's electric facilities, and (B) no electric power and energy will be introduced into the electric system of the Cooperative or any other entity.

- 1.7 Point of Common Coupling – The point at which a DER Facility is connected to the Cooperative’s electric distribution system.
- 1.8 Radially Operated System – An electric distribution system that is normally operated with only one supplying line connected to a load at any one time.
- 1.9 Single Phasing Condition – Occurs when electric flows through one phase of a three-phase supply line or device is interrupted.
- 1.10 Short Circuit Contribution – The result, expressed as a percentage, of dividing the maximum short circuit contribution of the DER Facility (or Facilities) by the short circuit contribution available from the Cooperative’s system, without the DER Facility (or Facilities).
- 1.11 Supplemental Review – Review of functional technical requirements to determine acceptability of equipment to be used to connect and safely operate the DER Facility on the Cooperative’s lines.
- 1.12 System Impact Study – An engineering study to assess the ability of the existing cooperative system to accommodate connection and safe operation of the DER Facility.
- 1.13 Unintentional Island – An unplanned condition where a portion of the Cooperative’s electric distribution system that is physically disconnected from the Cooperative’s power supply remains energized as a result of power supplied by one or more DER facilities.

CONSUMER DESIGN REQUIREMENTS

For an interconnection to be safe for the Cooperative’s employees and equipment and other consumers, the following minimum conditions are required to be met by DER Facilities. At the discretion of the Cooperative, additional conditions may be required to be met:

- 2.1 DER Facilities must meet; All applicable national, state, local, and Firelands construction regulations; Operation and maintenance related safety codes, such as National Electrical Code (NEC), National Electrical Safety Code (NESC), and Occupational Safety and Health Administration (OSHA) requirements. All interconnections of DER Facilities must comply with the following standards and their future amendments; IEEE 1547 – Standard for Interconnecting Distributed Resources with Electric Power Systems, approved June 12, 2003, and IEEE 1547.1 – Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems, approved June 9, 2005, which standards are incorporated herein.
- 2.2 DER Facility owner must provide the Cooperative with a detailed schematic showing the configuration and location of the proposed DER system and associated components, including the protections and controls, disconnection devices, nameplate rating of each device, power factor rating, transformer connections, and other information deemed relevant by the DER owner and/or the Cooperative. If the proposed DER system does not pass the screening process for simplified interconnection, Exhibit 2 attached hereto, additional information may be necessary from the DER Facility owner if changes to the Cooperative system may be required. In no event, other than from a Qualifying Facility, shall a consumer deliver into the electric distribution system of the Cooperative any electric power or energy, ancillary services (including, without limitation, reactive power), or other output of a DER facility. The owner or operator of the DER Facility, other than a Qualifying Facility, shall provide, install, own, operate and maintain, at its own cost and expense, all facilities and equipment as are required to prevent delivery into the Cooperative’s electric distribution system of any electric power or energy, ancillary services (including, without limitation, reactive power), or other output of the DER Facility.
- 2.3 DR equipment must be equipped with adequate protection and control to trip¹ the unit offline during abnormal² system conditions, according to the following requirements:
 - 2.3.1 For three phase generation, loss of balanced three-phase voltage or a single phasing condition within the trip times indicated in 2.3.1 when voltage on at least one phase reaches the abnormal voltage levels.
 - 2.3.2 Undervoltage or overvoltage within the trip time indicated below. By agreement of both the DER owner and the Cooperative, different settings may be used for the under voltage and over voltage trip levels or time delays.

V= Nominal System Voltage	Maximum Trip Time
$V < 50\%$	10 cycles
$50\% \leq V < 88\%$	120 cycles
$110\% < V < 120\%$	60 cycles
$V \geq 120\%$	6 cycles

¹ To trip is to automatically (without human intervention required) open the appropriate disconnection device to separate the DER equipment from the Cooperative's power system.

² Abnormal system conditions include faults due to adverse weather conditions including but not limited to, floods and lightning; vandalism, and other acts that are not under the control of the Cooperative. These conditions may also result from improper design and operation of the consumer's facilities resulting from non-compliance with accepted industry practices.

- 2.3.3 Underfrequency or over frequency: All DER Facilities shall follow the associated Cooperative distribution line frequency within the range 59.3 Hz to 60.5 Hz. DER Facilities rated at less than 10 kW shall disconnect from the Cooperative within 10 cycles if the frequency goes outside this range. A DER rated more than 10 kW shall (1) disconnect from the Cooperative within 10 cycles if the frequency exceeds 60.5 Hz, and (2) be capable of time delayed disconnection for frequencies in the range 59.3 Hz to 57 Hz. By agreement of both the DER operator and the Cooperative, different settings may be used for the under frequency and over frequency trip levels or time delays.
- 2.4 DER equipment requires the following additional protection to avoid damage to the Cooperative's system during normal, as well as abnormal system conditions.
 - 2.4.1 Synchronizing controls to insure a safe interconnection with the Cooperative's distribution system. The DER equipment must be capable of interconnection with minimum voltage and current disturbances. Synchronous generator installations, as well as other types of installations, must meet the following: slip frequency less than 0.2 Hz, voltage deviation less than + 10%, phase angle deviation less than + 10 degrees, breaker closure time compensation (not needed for automatic synchronizer that can control machine speed).
 - 2.4.2 A disconnect switch to isolate the DER equipment for purposes of safety during maintenance and during emergency conditions. The Cooperative requires a disconnect device or approved disconnect switch installed on the load side of the service's main/primary breaker, to be provided, installed by, and paid for by the consumer, which is readily accessible to, operable and lockable by Cooperative personnel, either at the primary voltage level, which shall include a lockable disconnect and a visible open and may include load-break cutouts, switches and elbows, or on the secondary voltage level, which may include a secondary breaker or switch. The switch must be clearly labeled as a DER disconnect switch.
- 2.5 DER equipment must have adequate fault interruption and withstand capacity, and adequate continuous current and voltage rating to operate properly with the Cooperative's system. A three-phase device shall interrupt all three phases simultaneously. The tripping control of the circuit interrupting device shall be powered independently of the utility AC source, for example by a battery or stored energy device, to permit operation upon loss of the Cooperative's distribution system connection.
- 2.6 Test results shall be supplied by the manufacturer or independent testing lab that verify, to the satisfaction of the Cooperative, compliance with the following requirements contained in this document:
 - 2.6.1 Anti-Islanding Inverters (2.13)
 - 2.6.2 Over/Under Voltage Trip Settings (ref. 2.3.1)
 - 2.6.3 Over/Under Frequency Trip Settings (ref 2.3.3)
 - 2.6.4 Synchronization (ref 2.4.1)

- 2.6.5 Harmonic Limits (tested at 25% of full load rating or at a level as close to the minimum level of rated output the unit is designed to operate as practical and at a level as close to 100% of full load rating (ref 2.7)
- 2.6.6 DC Current Injection Limits Inverters (ref 2.8)
- 2.6.7 Prevent Connection or Reconnection to De-energized System (ref 2.14)
If test results are acceptable to the Cooperative and if requested by a manufacturer, the Cooperative may supply a letter indicating the protective and control functions for a specific DER Facility model are approved for interconnection with the Cooperative's distribution system, subject to the other requirements in this document. The Cooperative reserves the right to review and reject the suitability of previously approved protective and control functions. The DER Facility owner shall have the DER Facility inspected by the Cooperative and any required local inspectors (i) to verify correct protective settings and connections of the DER Facility to the Cooperative's system prior to the first parallel operation, and (ii) shall have testing performed to the satisfaction of the Cooperative to verify proper operation of the DER Facility.
- 2.7 Harmonics and Flicker: The DER equipment shall not be a source of excessive harmonic voltage and current distortion and/or voltage flicker. Limits for harmonic distortion (including inductive telephone influence factors) will be as published in the latest issues of ANSI/IEEE 519, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems." Flicker occurring at the point of compliance shall remain below the Border Line of Visibility curve on the IEEE/GE curve for fluctuations less than 1 per second or greater than 10 per second. However, in the range of 1 to 10 fluctuations per second, voltage flicker shall remain below 0.4%. Refer to Exhibit 1. When there is reasonable cause for concern due to the nature of the generation and its location, the Cooperative may require the installation of a monitoring system to permit ongoing assessment of compliance with these criteria. The monitoring system, if required, will be installed at the DER owner's expense. Situations where high harmonic voltages and/or currents originate from the distribution system are to be addressed in the Interconnection Agreement.
³ Properly, in this context, means within the acceptable Cooperative or industry established practices. ⁴ For photovoltaic systems, a certification that the testing requirements of UL 1741 have been met may be used in place of these tests. ⁵ If the device is not designed to operate at this level, then the test should be at the lowest level at which it is designed to operate.
- 2.8 DC Current Injection from inverters shall be maintained at or below 0.5% of full rated inverter output current into the point of common coupling.
- 2.9 The DER Facility's generated voltage shall follow, not attempt to oppose or regulate, changes in the prevailing voltage level of the Cooperative at the point of common coupling, unless otherwise agreed to by the operators of the DER Facility and the Cooperative. DER Facilities installed on the downstream (load) side of the Cooperative's voltage regulators shall not degrade the voltage regulation provided to the downstream customers of the Cooperative to service voltages outside the limits of ANSI 84.1, Range A.
- 2.10 System Grounding: The DER Facility shall be grounded in accordance with applicable codes. The interconnection of the DER equipment with the Cooperative's system shall be compatible with the neutral grounding method in use on the Cooperative's system. For interconnections through a transformer to the Cooperative's system primary feeders of multi-grounded, four-wire construction, or to tap lines of such systems, the maximum un-faulted phase (line-to-ground) voltages on the Cooperative's system primary feeder during single line-to-ground fault conditions with the Cooperative's system source disconnected, shall not exceed those voltages which would occur during the fault with the Cooperative's system source connected and no DER Facilities connected.
- 2.11 System Protection: The DER owner is responsible for providing adequate protection to the Cooperative's facilities for conditions arising from the operation of generation under all the Cooperative's distribution system operating conditions.

The owner is also responsible for providing adequate protection to their facility under any of the Cooperative's distribution system operating conditions whether or not their DER is in operation. Such conditions may include but are not limited to:

1. Loss of a single phase of supply,
 2. Distribution system faults,
 3. Equipment failures,
 4. Abnormal voltage or frequency,
 5. Lightning and switching surges,
 6. Excessive harmonic voltages,
 7. Excessive negative sequence voltages,
 8. Separation from supply,
 9. Synchronizing generation, and
 10. Re-synchronizing the Owner's generation after electric restoration of the supply.
- 2.12 Feeder Protective Coordination. In the case of a Cooperative distribution system initiation of a trip of a protective device, the DER Facility protection and controls shall be designed to coordinate with the Cooperative's protective device and shall isolate the DER Facility from the Cooperative's lines.
- 2.13 Unintentional islanding: For an unintentional island in which the DER and a portion of the Cooperative's system remain energized through the point of common coupling, the DER shall cease to energize the Cooperative system.
- 2.14 The DER shall be designed to prevent the DER Facility from being connected to a deenergized Cooperative system. The consumer's DER facility should not reconnect to the Cooperative's system after a trip from a system protection device until the Cooperative's system is re-energized for a minimum of five minutes.
- 2.15 If the consumer connects a backup generator directly to the consumer's wiring to serve any load on the consumer's site, a double-throw transfer switch shall be utilized in order to ensure that no power is fed back onto the Cooperative's distribution system. *This is a critical safety requirement.*
- 2.16 Voltage deviation from normal the Cooperative's line voltage at the point of common coupling caused by the DER Facility shall not under any condition exceed 3%, calculated by dividing the maximum deviation from average line voltage by the average line voltage, with the result multiplied by 100.

CUSTOMER OPERATING PROCEDURES

- 3.1 If high-voltage, low-voltage, or voltage flicker complaints arise from other consumers due to the operation of the consumer's DER, the consumer may be required to disconnect their generation equipment from the Cooperative's system until the problem has been resolved.
- 3.2 The operation of the DER equipment must not result in harmonic currents or voltages at the point of common coupling that will interfere with the Cooperative's metering accuracy and/or proper operation of facilities and/or with the loads of other consumers. Such adverse effects may include, but are not limited to heating of wiring and equipment, over-voltage, communication interference, etc. If such a condition is found, the Cooperative may require the DER Facility to be disconnected from the Cooperative's lines until the problem is resolved.
- 3.3 The DER Facility owner must discontinue parallel operation when requested by the Cooperative. If the Cooperative has notified the DER Facility owner that an emergency- situation exists, the DER Facility owner shall immediately discontinue parallel operation of the DER Facility with the Cooperative's lines.