Midwest Electric, Inc.
Technical Guidelines
for Interconnection and Parallel Operation

APPLICABILITY

These rules apply to interconnection and parallel operation of DR (Distributed Resource) equipment that, in sum, is rated less than 20 MVA on radially operated Cooperative distribution lines up to 12.47 kV three phase (7.2 kV single phase). Interconnections to higher voltage lines will be made at the discretion of the Cooperative.

1.0 DEFINITIONS

Distributed Resource (DR)/ DR 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 20 MVA, connected to 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.

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".

Facilities Study – An engineering study conducted to determine the modifications to the existing cooperative system that will be needed to accommodate connection and safe operation of the DR Facility.

Harmonic Distortion – Distortion of the normal sine waveform; typically caused by nonlinear loads or by inverters attached to the system on customer premises.

Interconnection Agreement – A legal contract for the connection of the DR 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 DR Facility owner.

Permitted Synchronized Generation Facilities – Electric generation facilities equal to or greater than 25 kW but not more than 10 MVA, 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.

Point of Common Coupling – The point at which a DR Facility is connected to the Cooperative's electric distribution system.

Radially Operated System – An electric distribution system that is normally operated with only one supplying line connected to a load at any one time.

Single Phasing Condition – Occurs when electric flow through one phase of a three phase supply line or device is interrupted.

Short Circuit Contribution – The result, expressed as a percentage, of dividing the maximum short circuit contribution of the DR Facility (or Facilities) by the short circuit contribution available from the Cooperative's system, without the DR Facility (or Facilities).

Supplemental Review - Review of functional technical requirements to determine acceptability of equipment to be used to connect and safely operate the DR Facility on the Cooperative's lines.

System Impact Study – An engineering study to assess the ability of the existing cooperative system to accommodate connection and safe operation of the DR Facility.

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 DR facilities.

2.0 CUSTOMER DESIGN REQUIREMENTS

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

2.1 DR Facilities must meet all applicable national, state, and local construction, 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 DR Facilities must comply with IEEE 1547-2018 – Standard for Interconnecting Distributed Resources with Electric Power Systems, approved February 15, 2018, and IEEE 1547.1-2020 – Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems, approved May 21, 2020, which standards are incorporated herein.

2.2 DR Facility owner must provide the Cooperative with a one-line diagram showing the configuration of the proposed DR system, including the protection and controls, disconnection devices, nameplate rating of each device, power factor rating, transformer connections, and other information deemed relevant by the DR owner and/or the Cooperative. If the proposed DR system does not pass the screening process for simplified interconnection, Exhibit 2 attached hereto, additional information may be necessary from the DR Facility owner, and Cooperative system changes 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 of the electric power or energy, ancillary services (including, without limitation, reactive power), or other output of a DR facility. The owner or operator of the DR 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 of the electric power or energy, ancillary services (including, without limitation, reactive power), or other output of the DR Facility.

2.3 DR equipment must be equipped with adequate protection and control to trip[1] the unit off line during abnormal[2] system conditions, according to the following requirements:

2.3.1 Undervoltage or overvoltage within the trip time indicated below. By agreement of both the DR owner and the Cooperative, different settings maybe used for the under voltage and over voltage trip levels or time delays.

[1] To trip is to automatically (without human intervention required) open the appropriate disconnection device to separate the DR equipment from the power system.

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

V= Nominal System Voltage	Maximum Trip Time
V<45%	10 cycles
45%≤V<70%	120 cycles
110%<V<120%	120 cycles
V≥120%	10 cycles

2.3.2 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.

2.3.3 Underfrequency or overfrequency: All DR Facilities shall follow the associated Cooperative distribution line frequency within the range 58.5 Hz to 61.2 Hz. DR Facilities shall follow these trip settings per 1547-2018:
<56.5 Hz: 10 cycles
>56.5 Hz and <58.5 Hz: 300 seconds
>61.2 Hz and <62 Hz: 300 seconds
>62 Hz: 10 cycles
By agreement of both the DR operator and the Cooperative, different settings may be used for the under frequency and over frequency trip levels or time delays.

2.4 DR 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 DR 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 DR equipment for purposes of safety during maintenance and during emergency conditions. The Cooperative may require a disconnect device to be provided, installed by, and paid for by the customer, which is readily accessible to and operable and lockable by Cooperative personnel, either at the primary voltage level, which shall include a lockable disconnect and a visible open, 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 DR disconnect switch.

2.5 DR equipment must have adequate fault interruption and withstand capacity, and adequate continuous current and voltage rating to operate properly[3] 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, in order to permit operation upon loss of the Cooperative 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[4]:

2.6.1 Over/Under Voltage Trip Settings (ref. 2.3.1)
2.6.2 Over/Under Frequency Trip Settings (ref 2.3.3)
2.6.3 Synchronization (ref 2.4.1)
2.6.4 Harmonic Limits (tested at 25%[5] 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 as practical) (ref 2.7)
2.6.5 DC Current Injection Limits (Inverters) (ref 2.8)
2.6.6 Anti-Islanding (Inverters) (2.13)
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 DR 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 the suitability of previously approved protective and control functions.

The DR Facility owner shall have the DR Facility inspected by the Cooperative and any required local inspectors (i) to verify correct protective settings and connections of the DR Facility to the Cooperative 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 DR Facility.

2.7 Harmonics and Flicker: The DR 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 IEEE 1547-2018 (TRD), and the latest issues of ANSI/IEEE 519, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

[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.

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 DR owner's expense. Situations where high harmonic voltages and/or currents originate from the distribution system are to be addressed in the Interconnection Agreement.

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 DR 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 DR Facility and the Cooperative. DR 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 DR Facility shall be grounded in accordance with applicable codes. The interconnection of the DR 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 Cooperative system primary feeders of multi-grounded, four-wire construction, or to tap lines of such systems, the maximum unfaulted phase (line-to-ground) voltages on the Cooperative system primary feeder during single line-to-ground fault conditions with the Cooperative system source disconnected, shall not exceed those voltages which would occur during the fault with the Cooperative system source connected and no DR Facilities connected.

2.11 System Protection: The DR owner is responsible for providing adequate protection to Cooperative facilities for conditions arising from the operation of generation under all Cooperative distribution system operating conditions. The owner is also responsible for providing adequate protection to their facility under any Cooperative distribution system operating condition whether or not their DR 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 protective function initiating a trip of a Cooperative protective device, the DR Facility protection and controls shall be designed to coordinate with the Cooperative protective device, and shall isolate the DR Facility from the Cooperative's lines.

2.13 Unintentional islanding: For an unintentional island in which the DR and a portion of the Cooperative's system remain energized through the point of common coupling, the DR shall cease to energize the Cooperative system.

2.14 The DR shall be designed to prevent the DR Facility from being connected to a de-energized Cooperative system. The customer should not reconnect the DR Facility 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 customer connects a backup generator directly to the customer's wiring to serve any load on the customer's site, he shall utilize a double-throw transfer switch 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 Cooperative line voltage at the point of common coupling caused by the DR 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.

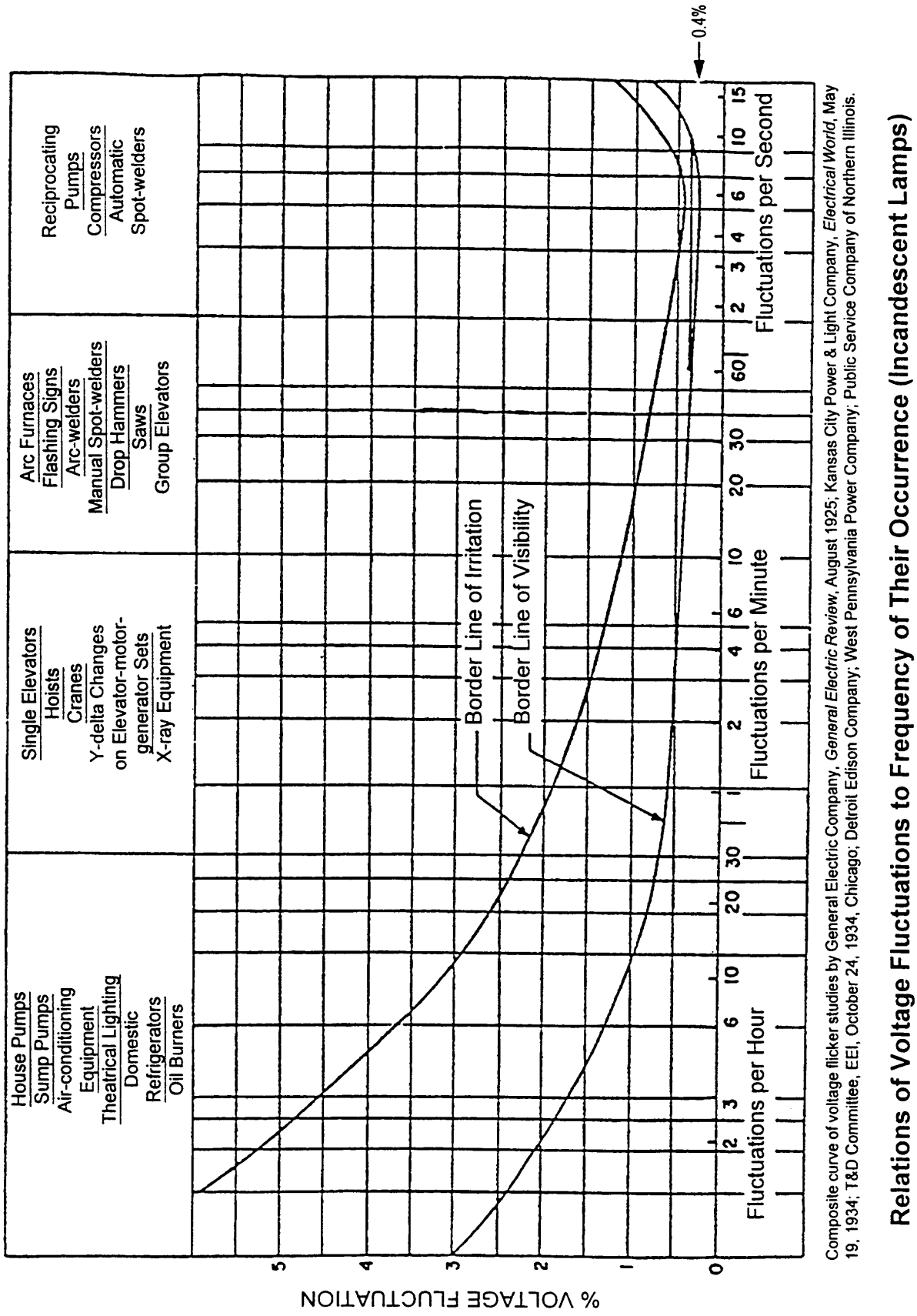
3.0 CUSTOMER OPERATING PROCEDURES

3.1 If high-voltage, low-voltage, or voltage flicker complaints arise from other customers due to the operation of customer DR, the customer may be required to disconnect his or her generation equipment from the Cooperative's system until the problem has been resolved.

3.2 The operation of the DR 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 customers. 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 DR Facility to be disconnected from the Cooperative lines until the problem is resolved.

3.3 The DR Facility owner must discontinue parallel operation when requested by the Cooperative after prior notice. If the Cooperative has notified the DR Facility owner that an emergency situation exists, the DR Facility owner shall immediately discontinue parallel operation of the DR Facility with the Cooperative's lines.

Exhibit 1



Composite curve of voltage flicker studies by General Electric Company, *General Electric Review*, August 1925; Kansas City Power & Light Company, *Electrical World*, May 19, 1934; T&D Committee, EEI, October 24, 1934, Chicago; Detroit Edison Company; West Pennsylvania Power Company; Public Service Company of Northern Illinois.

Relations of Voltage Fluctuations to Frequency of Their Occurrence (Incandescent Lamps)

INTERCONNECTION REQUEST SCREENING PROCESS

