INTERCONNECTION STANDARDS

FOR

DISTRIBUTED ENERGY RESOURCES

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COLORADO

Rev. 3
June 2019

INTERCONNECTION STANDARDS FOR DISTRIBUTED ENERGY RESOURCES

1 INTRODUCTION

1.1 These standards have been established to assist distributed energy resources (DER) in planning and designing an electrical interconnection with the systems of Empire Electric Association (EEA) and Tri-State Generation & Transmission Association (Tri-State). This document should guide DER and EEA personnel when planning, installing and operating any non-utility owned generating equipment. The following requirements are general in nature and may not cover all details of a specific installation. Potential DER should discuss project plans with EEA before purchasing or installing equipment.

1.2 EEA encourages and will assist with the development of DER projects whenever this can be done without adverse effects on the general public or to EEA's equipment or personnel. To help achieve the maximum reliability and use of small power projects, EEA will provide the potential DER with information, technical assistance, and other aid the DER might require in the evaluation of the technical and economic feasibility of the project.

2 GENERAL REQUIREMENTS FOR INTERCONNECTION

2.1 The DER must ensure that the facility and its associated equipment comply with any applicable local, state, and federal government requirements or regulations, and any requirements from EEAs power supplier, transmission operator, balancing authority or any other entity having jurisdiction over the power grid.

2.2 Certain protective equipment (relays, circuit breakers, etc.) specified by EEA must be installed at locations where the customer wishes to operate DER facilities in parallel with EEA's system. The purpose of this equipment is to ensure safe and reliable power system operation and to allow prompt disconnection of the DER in the event of short circuit or other malfunction. Other changes, such as revisions to the electrical system configuration and/or modifications to protective equipment at other locations, may also be required in order to accommodate parallel operation. EEA will assist DER owners in determining interconnection requirements. This document gives general information about parallel operation; however, EEA may impose additional restrictions or require additional equipment when the particular installation so warrants. Each DER must be reviewed individually, since interconnection requirements vary with the type of equipment and the proposed location on EEA's system. All costs associated with interconnection, necessary system additions, and modifications to accommodate the DER will be borne by the DER.

2.3 EEA requires that the customer design, construct and operate their equipment in a manner which will not degrade the quality of service to other EEA customers. This requires that the DER equipment be designed, specified and installed in a manner appropriate to its intended service and in accordance with all applicable standards regulating design, construction and operation of such equipment. EEA reserves the right to specify the quality and determine the adequacy of customer equipment, installation and operation in any respect which affects safety, reliability or quality of service.

2.4 EEA will not assume responsibility for protection of any of the DER's equipment. The DER is fully responsible for properly protecting its equipment. Equipment which is not properly protected may be damaged as the result of both normal system or abnormal operation or disturbances on EEA's system. EEA will, however, assist the DER in determining conditions to which its equipment is likely to be subjected as a result of probable system operation, malfunctions or disturbances, insofar as it is possible to determine these conditions in advance.

2.5 For DERs greater than 25 kW of capacity, a permanent and weather proof sign indicating the location of the DER Generation Disconnect shall be clearly displayed at the electrical service (generally at the customer meter), and shall also include the names and current telephone numbers of at least two persons that are authorized to provide access to the DER and who have authority to make decisions regarding the DER interconnection and operation. This telephone listing shall be updated as needed to maintain its usefulness.

2.6 For interconnection of a DER to a radial distribution circuit, the aggregated generation, including the proposed DER, on the circuit shall not exceed 15% of the line section annual peak load as most recently measured at the substation or calculated for the line section. A line section is that portion of EEA's electric system connected to a customer bounded by automatic sectionalizing devices or the end of the distribution line. Exceptions may be allowed on a case-by-case basis where safe system operation can be proven and as approved at EEAs discretion.

2.7 The DER, in aggregation with other generation on the distribution circuit, shall not contribute more than 10% to the distribution circuit's maximum fault current at the point on the distribution feeder voltage (primary) level nearest the proposed point of change of ownership.

2.8 The DER, in aggregation with other generation on the distribution circuit, shall not cause any distribution protective devices and equipment (including, but not limited to, substation breakers, fuse cutouts, and line reclosers), or DER equipment on the system to exceed 87.5 % of the short circuit interrupting capability; nor shall the interconnection be allowed for a circuit that already exceeds 87.5 % of the short circuit interrupting capability.

2.9 If the DER is to be interconnected on single-phase shared secondary, the aggregate generation capacity on the shared secondary, including the DER, shall not exceed 10 kW for residential or 25kW for non-residential services.

2.10 If the DER is single-phase and is to be interconnected on a center tap neutral of a 240 volt service, its addition shall not create an imbalance between the two sides of the 240 volt service of more than 20%.

2.11 It is preferred that 3-phase services only have balanced 3-phase DER systems, in accordance with NEC 705.100 and ANSI C84.1. Use of single-phase distributed generation on a 3-phase service may require that the service be placed on its own transformer as determined at EEAs discretion.

2.12 A single-phase distributed generation system may be interconnected to a 3-phase service where a single generator of less than 10KW AC is installed and voltage imbalance can be proven to not exceed 3% in accordance with ANSI C84.1. The single-phase generator of less than 10KW AC shall be connected to the two phases which have the historically higher loads. Whenever more than 1 inverter is used, the inverters shall be connected in a manner which is as balanced as possible across all 3 phases.

2.13 Where multiple single-phase distributed generators are connected to a 3-phase service, the system shall be designed so that the loss of voltage on any one phase of the system will cause generation on all 3 phases to cease until such time that voltage is restored.

3 CODES, STANDARDS AND REGULATORY AGENCIES

The DER must ensure that the facility and all equipment connected therewith comply with the National Electrical Code, the National Electrical Safety Code, IEEE and other applicable standards (see Appendix II) and/or any applicable local, state, and federal government requirements, whichever are more stringent. For DERs with a design capacity greater than 25kW AC or as determined by EEA, the DER must submit a statement from a registered Professional Electrical Engineer currently licensed in the state of the project's location (Colorado or Utah as applicable) certifying that the design of the DER and its interconnection equipment complies with EEA requirements and with reasonable interconnection safety and design standards and prudent electrical practices. The DER agrees to hold EEA harmless for any damage to person or loss to property arising out of the DER's failure to comply with such codes or legal requirements. The DER's installation must be inspected and certified by an Electrical Inspector acceptable to the Authority Having Jurisdiction (AHJ) before the generation equipment may be energized or interconnected. Inspection and startup procedures will conform to the appropriate state commission rules. Grounding shall be in accordance with applicable sections of the National Electrical Code (NEC) and the National Electrical Safety Code (NESC) and shall conform to IEEE Standard 142, "IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems" and RUS Bulletin 65-1, "Guide for the Design of Substations," where applicable. For a summary of applicable codes and standards, see Appendix II.

4 SYNCHRONOUS GENERATORS

4.1 Synchronous generators have several features which make them desirable from a utility system standpoint, but the excitation and synchronization equipment required often make these generators economically unfeasible, except in the larger sizes. The synchronous generator with associated excitation equipment is able to supply its own reactive power and hence may operate at unity or lagging power factor. DERs are required to supply sufficient reactive power capability to withstand normal voltage variations on EEA's system and to maintain essentially unity power factor. This operation enhances generator stability and alleviates the need for supplemental power factor correction equipment.

4.2 Synchronous generators require automatic synchronization equipment and supervisory relays to prevent closure into EEA's network when the DER generator is improperly synchronized. Reclosure of an isolated synchronous generator onto the system may cause damage to that generator or associated equipment if the generator and system are not properly synchronized. Automatic reclosure of circuit breakers or circuit reclosers is commonly used on distribution and subtransmission lines in order to increase the system reliability. Changes to existing EEA equipment may be required to prohibit reclosure into a synchronous generator. Other protective relaying may be required to account for overspeed, excitation overvoltage, loss of excitation, loss of synchronism, frequency deviation, field ground, neutral overvoltage and reclosure control. Suggested minimum protective equipment requirements for synchronous generator installations are given in Section 3 by class of DER.

5 INDUCTION GENERATORS

5.1 Induction generator installations are in many respects simpler than synchronous generator systems but they pose additional problems. The induction generator may be started as a motor if current inrush, voltage regulation and lamp flicker are not serious problems. If the quality of service to other EEA customers is degraded due to induction generator starting, reduced voltage starting or other special procedures may be necessary to relieve the situation.

5.2 The induction generator cannot maintain constant voltage and frequency operation without an outside source of reactive power. EEA must supply this power under all operating conditions. The size and type of induction generator which may be interconnected at a given point on an existing EEA circuit is limited by the ability of that circuit to regulate voltage and maintain adequate quality of service to other EEA customers. EEA reserves the right to limit the application of induction generators on existing circuits and to specify modifications, if any, to the existing system to accommodate the DER. All such modifications will be made at the expense of the DER.

5.3 Capacitors installed at the generator may be required to limit the adverse effects of excess VAR flow on EEA's system. Installation of capacitors at or near an induction generator increases the risk that the machine may become self-excited if it is completely isolated from or isolated with a relatively small portion of EEA's system. A self-excited induction generator can produce power of abnormal voltage and frequency. This unregulated power may damage equipment of other customers who are electrically connected to the isolated generator.

5.4 To minimize the risk of self-excited operation, the compensation installed at or near an induction generator should be limited to that value necessary to correct the no-load power factor to 95 percent. Over and under-frequency relays and voltage regulation relays will also be required on all induction generators to protect against self-excited operation. Other protective equipment such as voltage restrained overcurrent relays may be required to reduce the possibility of damage to EEA equipment or the equipment of other customers. Where self-excitation problems appear likely, it may be necessary to rearrange the distribution network to avoid isolating the induction generator with a small attached load. Costs of power factor correction equipment, protective equipment and any EEA system changes must be borne by the DER.

5.5 Reclosure of a distribution line after a utility system disturbance may cause damage to the customer's induction generator if adequate protective equipment is not installed to mitigate the adverse effects. The DER is responsible for ensuring its equipment is adequately protected.

6 INVERTER SYSTEMS

6.1 Inverter systems are used to transform direct current to alternating current. The resulting waveform may be rich in harmonics. These nonstandard waveforms may cause radio and television interference on other customers' equipment as well as producing objectionable audible noise.
Excessive harmonic content may also cause overheating in electrical equipment.

6.2 The inverter system should be designed and operated in accordance with UL1741. This standard ("Inverters, Converters, and Controllers for Use in Independent Power Systems") addresses the electrical interconnection design of various forms of generating equipment. Many manufacturers submit their equipment to a Nationally Recognized Testing Laboratory (NRTL) that verifies compliance with UL1741. This "listing" is then marked on the equipment and supporting documentation.

6.3 All three-phase inverter installations shall be served by a dedicated transformer which is connected delta on the customer side and grounded wye on EEA's side. The cost of this transformer and associated equipment shall be borne by the DER.

6.4 Inverter systems require a significant reactive power flow to ensure proper operation.
EEA requires the customer to provide equipment to correct the power factor. However, care must be taken to ensure that an inverter system which is electrically close to capacitors cannot drive an isolated load. Self-commutated inverters as well as line-commutated inverters connected to rotating machines may operate in a self-excited mode. In order to protect EEA's equipment and other customers' equipment, the DER shall install protective relays to prevent isolated operation. For the purpose of preventing service to isolated loads, inverter systems shall conform to standards outlined in IEEE 929.

7 PROTECTION OF THE UTILITY SYSTEM

7.1 In order to be assured of continuing safe, reliable service to EEA customers, EEA must be concerned with the manner in which DER are connected to the existing EEA system. EEA's concerns are fourfold:

i. The DER must immediately disconnect from EEA in the event of a utility system disturbance;
ii. The DER must disconnect in the event of a malfunction or disturbance on the DER equipment;
iii. The DER must not backfeed a de-energized EEA line; and
iv. The DER must not degrade the quality of service to other EEA customers.

7.2 Utility System Disturbances

7.2.1 In the event of a utility line fault or other system disturbance, protective equipment will promptly act to de-energize the affected line section. A DER connected to this portion of line represents an additional source of power to energize the line. Thus, the DER's equipment must also automatically act to disconnect the generator(s) to avoid contributing to the severity of the fault, to avoid isolated operation and to protect the DER and utility equipment.

7.2.2 Isolated operation occurs when a portion of the EEA load becomes separated from the EEA source but is still connected to the parallel generation. If the isolated load is sufficiently large with respect to the rated output of the DER generators, the voltage will collapse and protective relays will take the machines off line. When the generator rating is greater than or comparable to the size of the isolated load, sustained independent operation becomes possible. This situation is intolerable, since the voltage and frequency on the isolated network may be poorly regulated; damage to EEA equipment, or that of other customers, is likely to result. Restoration of normal service to this island is also hampered by the presence of an isolated energy source which may not be synchronized with the grid.

7.2.3 In instances where EEA's system arrangement is such that it is possible that the generators will not always be isolated with a sufficiently large load to prevent independent operation, EEA requires the installation of voltage and frequency relays, even on the smallest DERs. For installations with rated capacity of greater than 10 kW, specific devices are required to detect faults on EEA's system as well as voltage and frequency relays (or equivalent control system functionality) to detect isolated operation. Equipment may also be required on EEA's system to provide additional assurance that islanded operation does not continue. The need for such equipment will be determined on a case-by-case basis at EEA's discretion.

7.3 DER Disturbances

To prevent loss of service to other EEA customers, the DER must provide protective equipment to promptly disconnect the DER's generators in the event of a fault or other disturbance on the DER's installation. The protective equipment must be coordinated with EEA's equipment to ensure proper operation in the event of a fault. EEA will assist the DER to properly coordinate the protective equipment.

7.4 Backfeed to Utility System

The DER's generators provide an additional source of power for EEA's network. The DER must provide protective equipment sufficient to give positive assurance that the generators cannot be connected to an otherwise de-energized EEA line. This prevents a potential hazard to EEA personnel who may be in contact with the line for maintenance purposes. In addition to an automatic fail-safe device, EEA will require for all DER greater than10kW AC an accessible, visible open disconnect device that is visibly marked "Generation Disconnect" and has the capability of isolating the energy generated by each DER. This device must be lockable in the open position and may be operated by either party at any time in order to maintain safe operating conditions. At a minimum, this protection can be provided by an isolation switch which can be locked in the open position by EEA to visibly indicate isolation of the DER. Other equipment such as undervoltage, synchronizing, voltage phase sequence or reclosure relays may also be required. The generation disconnect switch must be accessible to EEA at all times. Gates, doors or other means of access control must accommodate the use of an EEA keyed padlock.

If it is discovered that any equipment connected to the EEA system is in EEA's judgment problematic or is considered to be unsafe it will be disconnected immediately from the EEA system.

7.5 Power Quality

7.5.1 The DER will not be allowed to degrade the quality of power delivered to other EEA customers. The DER will be expected to operate within the limits on voltage, frequency and harmonic content as outlined in Appendix II.

7.5.2 The DER synchronous generation is expected to operate at as nearly unity power factor as is practical to prevent voltage flicker upon switching. The generator and associated equipment are expected to be engineered to allow stable unity power factor operation without exceeding the voltage regulation limits outlined in RUS Bulletin 169-4, "Voltage Levels." Power factor limits on DER induction generators are discussed in Section 2.3. Should voltage regulation or lamp flicker become a problem, then operational restrictions may be imposed until the situation can be corrected.

7.5.3 Excess harmonic content or unnecessary service interruptions will not be allowed. If degradation in quality of service to other EEA customers or interference with the operation of EEA equipment occurs, EEA will disconnect the DER generators until such time as the problem is resolved.

7.6 Protective Equipment

The type and quality of protective equipment required will depend on the size and type of the DER generation equipment as well as the electrical characteristics of EEA's interconnection. At a minimum, this equipment will consist of a circuit breaker with associated relaying, a disconnect switch, and voltage and frequency regulation relays. Additional equipment may be necessary for a given installation. The equipment specified above may be part of a vendor-supplied control package, providing the desired level of protection is ensured. Any such protective equipment must be reviewed & approved by EEA for each application. EEA shall be the only judge of adequacy and suitability of protective equipment for DER installations.

8 PROTECTION OF DER

8.1 The DER is solely responsible for protection of its equipment. To facilitate its design, EEA herein lists potential hazards to the DER equipment which might occur as a result of interconnection with EEA's system. The probable hazards are of three types: those that occur as a direct result of a faulted transmission or distribution line, synchronism problems, and voltage surges or sags.

8.2 Transmission and distribution lines are susceptible to both short circuits and ground faults. Both of these line faults may produce excessive phase currents, single-phased supply and excessive negative sequence currents. Typical equipment to sense and protect against these hazards are listed in Section 3 by class of DER.

8.3 The DER generator can be damaged by interconnection with EEA's system if the voltage, phase sequence or phase angle of the machine does not match that of the system. For synchronous generators the customer must provide either automatic synchronizing equipment or a synchronizing relay to supervise manual closure. Unsupervised manual synchronizing is not permitted. Induction starting will be allowed if the inrush current is not excessive. Should voltage dip or lamp flicker problems result from induction starting, other steps must be taken to eliminate these problems.

8.4 Damage may result to a DER generator as a result of automatic reclosure unless proper protection is provided. EEA's transmission and distribution lines are usually equipped with circuit reclosures which, after a time delay, attempt to restore a circuit which has been tripped due to a fault. If the fault was temporary, the reclosure is successful and the circuit is restored to service; if not, the circuit is locked out until manual reclosure is attempted. The recloser may attempt to restore the circuit several times before lockout occurs. If the DER was not taken off-line when EEA's circuit was opened, the DER and EEA's system may not reclose in synchronism. Voltage surges and damaging torque may occur upon reclosure. Protective devices should be installed to trip the DER before reclosure is attempted and to prohibit reclosure into EEA's system if EEA's voltage is of abnormal magnitude or phase sequence. Modifications to EEA's recloser or addition of other equipment may be required to protect the DER. The cost of such modifications will be charged to the DER.

8.5 Transient voltage surges may occur on EEA lines due to switching operations or lightning strikes. The DER should have protective devices to mitigate the effects of these surges as well as direct lightning strikes. Inverter systems and other solid-state components are particularly susceptible to damage by voltage surge.

8.6 Details of typical protective equipment to sense and mitigate the potential hazards described above are given in Section 3 by class of DER.

9 INSPECTION AND MAINTENANCE

The DER shall not commence interconnected operation, until:

1) The DER has supplied EEA with a completed Application for Interconnection on a form supplied by EEA for review and acceptance.
2) The DER has obtained a certificate of code compliance from the appropriate Electrical Inspector as determined by the Authority Having Jurisdiction;
3) EEA has made any necessary modifications to its system to accommodate the DER;
4) EEA or its approved 3rd party has inspected and tested the DER and certified, in writing, that the DER has complied with all requirements for interconnection;
5) The DER has submitted proof of adequate insurance;
6) EEA provides written authorization.

9.1 The completed installation will be subject to a final inspection and test by EEA for compliance before parallel operation is permitted. EEA will determine satisfactory performance.

9.2 The DER must notify EEA prior to any modifications made to the DER or to the interconnection between the DER and EEA. The DER must receive approval from EEA prior to proceeding with such modifications. The DER must permit EEA, at any time, to install or modify any equipment, facility, or apparatus to protect the safety of its employees and ensure the accuracy of its metering equipment. These costs will be borne by the DER.

9.3 The DER must permit EEA employees to enter its property at any time for the purpose of inspecting and/or testing the interconnection facilities to ensure their continued safe operation and the accuracy of EEA's metering equipment, but such inspection does not relieve the DER of the obligation to maintain the facilities in satisfactory operating condition.

The DER shall discontinue parallel operations when requested by EEA:

1) To facilitate maintenance, test or repair of utility facilities;
2) During system emergencies;
3) When the DER's generating equipment is interfering with other customers on the system;
4) When an inspection of the DER reveals a condition likely to be hazardous to EEA's system; and
5) When an inspection of the DER reveals that the generating equipment is operating outside allowable limits on voltage, frequency, power factor or harmonic content.

9.4 The DER shall operate and maintain the interconnection equipment at its cost unless previous arrangements have been made with EEA to maintain the interconnection. In this case, EEA will operate and maintain the interconnection and bill the DER for these services.

9.5 In all other respects, inspection and maintenance of the DER shall conform to applicable Colorado Public Utilities Commission regulations or Utah Public Service Commission regulations as determined by the appropriate location.

10 IMPORTANT CONSIDERATIONS FOR INTERCONNECTION

10.1 The DER should allow adequate time in the design and construction schedule for design interface meetings with EEA and for material procurement by EEA. This time will vary depending on the DER's location, size, design, specific operating and system requirements, and the availability of materials needed to accomplish the interconnection.

10.2 If it is discovered that any equipment connected to the EEA system is in EEA's judgment problematic or is considered to be unsafe it will be disconnected from the EEA system.

10.3 DERs that generate electrical energy for on-site use only and are interlocked or otherwise prevented from feeding energy into the EEA system are special cases and may not be required to meet all of the requirements of this document. However, they are required to show by design and by operation that they cannot feed energy into the EEA system.

11 SPECIFIC REQUIREMENTS FOR INTERCONNECTION

EEA has established guidelines for the protection and interconnection of DER by size classes. These guidelines represent the minimum requirements for interconnection and recommended practice for DER equipment protection. The DER shall be the sole judge of what equipment is necessary to protect the DER generators and associated electrical equipment. EEA shall be the sole judge of what equipment is necessary to ensure a safe, reliable interconnection with EEA's system.

The size classes for DER are:

1) 10 kW and below;
2) 10-25 kW;
3) Greater than 25 kW;

11.1 DER OF 10 KW OR LESS (SINGLE OR THREE PHASE)

The following requirements assume a low density of parallel generation customers on the service circuit. EEA may impose additional requirements if necessary for safe, reliable service to other EEA customers.

The DER of 10 kW or less shall be required to provide:

1) A circuit breaker rated for the service to which it is applied;
2) A line voltage relay or equivalent control system functionality which will prevent the generator from being connected to a de- energized source;
3) Undervoltage and overvoltage relays or equivalent control system functionality;
4) Underfrequency and overfrequency relays or equivalent control system functionality;
5) A transformer dedicated to the service to which the DER is connected (for three phase inverter installations).

In addition, the DER should consider installation of:

1) Thermal cutouts to protect the generator from excessive currents or single phasing (if applicable); and
2) An overspeed relay, if applicable.

For DER of this size, the customer shall not install capacitors at the DER for power factor correction. EEA shall provide the reactive power requirements of the DER to avoid the potential for self-excitation.

11.2 DER OF 10-25 KW

The following requirements represent the minimum equipment necessary for safe, reliable interconnection. EEA may require additional equipment if the individual application warrants.

The DER of 10-25 kW shall be required to provide:

1) An isolation switch;
2) A circuit breaker;
3) Surge arrestors;
4) A transformer dedicated to the service to which the DER is connected; and

5) Protective relaying to provide the following functions:
   A) Short circuit protection (Devices 52, 51V);
   B) Isolation protection (Devices 27/59, 81);
   C) Breaker closing/reclosing control (Devices 25, 47); and
   D) Under and overspeed control (Device 15) for induction generators.

Section 3.4 gives a description of protective devices referred to in the preceding requirements.

11.3 DER GREATER THAN 25 KW (THREE PHASE ONLY)

DERs greater than 25 kW in capacity may be required to install separate utility grade generation metering and will be studied on a case-by-case basis by EEA and Tri-State to determine specific requirements.

11.4 PROTECTIVE DEVICE

DESCRIPTIONS Device Numbers for

Protective Equipment

15 - Tachometer Relay
25 - Synchronizing Relay
27 - Undervoltage Relay
32 - Directional Power Relay
40 - Generator Field Failure Relay
46 - Phase-Balance (Reverse-Phase) Relay
47 - Phase-Sequence Relay
51 - Time-Overcurrent Relay
   A) 51GB - Ground Bank Time-Overcurrent
   B) 51T - Transformer Time-Overcurrent
   C) 51V - Voltage-Restrained Time-Overcurrent or Voltage-Controlled Time-Overcurrent
52 - Circuit Breaker (52G - Generator Circuit Breaker)
59 - Overvoltage
64G - Ground Relay
67 - Directional Overcurrent
81 - Frequency Relay
87 - Differential Relay
   A) 87G - Generator Differential
   B) 87T - Transformer Differential
90 - Field Voltage Regulator
S.A. - Surge Arrestor

APPENDIX I

SUMMARY OF INTERCONNECTION PROCEDURE

1) Customer with potential DER contacts EEA and obtains Interconnection Application.

2) The DER submits the Application to EEA. If DER's nameplate capacity is greater than 10 kW, the DER Design Data Requirements shown in Appendix III are also required.

3) The DER provides notice of insurance coverage. The DER should investigate liability insurance coverage early in the planning stage.

4) EEA evaluates the Application for Interconnection for completeness and notifies the applicant of receipt of the Application, and if not complete advises what material is missing. Systems 25kW or greater may require EEA Board Approval.

5) EEA conducts preliminary engineering studies, if warranted, to determine the effect the DER might have on existing EEA customers and equipment. EEA determines if Facility Study or System Impact Study is required.

6) Provided all the criteria in the Interconnection Standards for Distributed Energy Resources are met, EEA approves and executes the Application and returns it to the Customer.

7) EEA designs and constructs the interconnection and modifies the existing EEA network as necessary to accept the DER.

8) DER System is inspected and approved by Authority Having Jurisdiction.

9) After installation, prior to parallel operation, EEA will inspect the DER for compliance with standards and may schedule appropriate metering replacement, if necessary.

10) EEA notifies the Customer in writing or by fax or e-mail that interconnection of the DER is authorized. If the witness test is not satisfactory, EEA has the right to disconnect the DER. The customer has no right to operate in parallel until a witness test has been performed.

11) Interconnection and startup.

APPENDIX II

SUMMARY OF CODES AND STANDARDS

General

- NFPA 70 (most current edition), National Electrical Code
- IEEE Std 929-2000 IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems
- UL 1741 Inverters, Converters, and Controllers for Use in Independent Power Systems
- IEEE1547 Standard for Interconnecting Distributed Resources with Electric Power Systems (including use of IEEE 1547.1 testing protocols to establish conformity)
- National Electrical Safety Code
- Local Building Codes
- NEMA MG 1-1998, Motors and Small Resources, Revision 3
- NEMA MG 1-2003 (Rev 2004), Motors and Generators, Revision 1
- ANSI C84.1-1995 Electric Power Systems and Equipment – Voltage Ratings (60 Hertz)
- IEEE Std 100-2000, IEEE Standard Dictionary of Electrical and Electronic Terms

Grounding

- REA Bulletin 65-1, "Design Guide for Rural Substations"
- IEEEStandard 142,"Recommended Practice for Grounding of Industrial and Commercial Power Systems”

Voltage Drop

- REA Bulletin 169-27, "Voltage Regulator Application on Rural Distribution Systems”
- REA Bulletin 169-4, "Voltage Levels on Rural Distribution Systems"

Phase Balance

- <3% (three phase difference)
- ANSI C84.1

Frequency

- +0.1 (for Qualifying Facility of rated capacity greater than 5 kW)

Harmonics

- IEEE Standard 519, "IEEE Guide for Harmonic control and Reactive Compensation of Static Power Converters"

Flicker

- REA Bulletin 160-3, "Engineering and Operations Manual - Service to Induction Motors"

Surge Control

- IEEE Std C62.41.2-2002, “IEEE Recommended Practice on Characterization of Surges in Low Voltage (1000V and Less) AC Power Circuits”
- IEEE Std C37.90.1-1989 (R1994), “IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems”
- IEEE Std C62.45-1992 (R2002), IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits

Interference

- IEEE Std C37.90.2 (1995), IEEE Standard Withstand Capability of Relay Systems to Radiated

Service Reliability

- Qualifying Facility shall not cause loss of service to other customers.

Other (May be Required)

- City/County Zoning or Building Permit
- Section 404 Clean Water Act Permit
- Colorado Department of Health
- Emission Permit/Fugitive Dust Permit
- Special Use Permit/Conditional Use Permit from County
- FAA Approval for tower

APPENDIX III

DER DESIGN DATA REQUIREMENTS

Empire Electric Association, Inc. (EEA), reviews all proposals for interconnection by a DER. EEA attempts, insofar as is reasonable, to determine whether a design will create problems on EEA's system but cannot comment or make assurances on the technical prudence or economic feasibility of a proposed project.

EEA cannot review your facility design until a complete design package is submitted. Typically, a complete design package would include:

(1) A complete site plan, detailing physical locations of all equipment to be installed from EEA's supply line to the DER system. This plan should show sufficient detail to determine physical clearances between pieces of equipment and between any piece of equipment and an adjacent permanent structure. The site plan should show the location of proposed metering, disconnecting and circuit protective devices. Particular detail should be given to physical location of equipment in the powerhouse, and provisions for grounding of powerhouse equipment (as applicable).

(2) A system one-line diagram which states:

- Wire sizes and types
- Service disconnecting means of each service disconnects and DER utility disconnect
- Ratings and types of circuit protective devices involved (fuse sizes/class, C/B trip ratings)
- Include all equipment which has been installed or which will be installed up to EEA's interconnection.
- Meter type/form

(3) A relay control diagram which clearly indicates relay contact arrangements and which indicates functionally the operation of all relays, protective devices and interlocks.

(4) Device types, sizes, model numbers, settings and manufacturer's data on all circuit protective devices and relays.

(5) The location, ratings, impedances, time constants and manufacturer's data for the generator and all associated control equipment, including but not limited to exciters, governors, voltage regulators and synchronizers, where applicable.

(6) The location, ratings and switching arrangement for power factor correction capacitors, if any.

(7) Proposed operating procedures for startup, shutdown and restart functions. The procedures should include all operational parameters and appropriate limits of operation.

(8) Anticipated peak power production and monthly energy production figures.

EEA recommends not purchasing equipment or beginning construction of facilities until a design review is completed and EEA gives final written design approval.

Revision Dates:

1. 12/2017 – Original
2. 7/2018 – Rev. 1
3. 12/2018 – Rev. 2
4. 6/25/19 – Rev. 3