



Southern Company

Alabama Power Company
Georgia Power Company
Mississippi Power Company

Operation of Distributed Energy Resources (DER) in Parallel with the Distribution System Policy

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Operation of DERs in Parallel with Distribution System Policy

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Operation of DERs in Parallel with Distribution System Policy

- 1.0 Introduction.** This Policy sets forth the minimum interconnection requirements and process for connection and safe parallel operation of a Distributed Energy Resource (DER) with Company's Distribution System. A DER Owner may incur costs associated with any corresponding facilities, improvements and upgrades needed for interconnection or the delivery of energy to the load of Company. This Policy identifies certain types of such costs; however, DER Owners should consult the applicable rules, regulations, requirements and rate schedules of the particular Company impacted by interconnection, as additional jurisdiction-specific information may exist that supplements or supplants the provisions set forth in this Policy.
- 2.0 Scope.** This Policy applies to a DER that is designed to operate in parallel with and export electric power to Company's Distribution System for more than 100 milliseconds. It does not apply to end-use Customer-owned emergency or standby generators that use open- or closed-transition schemes that create momentary parallel operation with Company's Distribution System for no more than 100 milliseconds. It also does not apply to generation resources that connect directly to the Company Transmission System, including a distribution substation.
- 3.0 Definitions.** Capitalized terms used in this Policy are defined below. Also, **"including"** means "including, but not limited to,"; **"include(s)"** means "include(s), without limitation,"; **"or"** means "either or both" ("A or B" means "either or both" ("A or B" means "A or B or both A and B"); and **"e.g."** means "for example, including, without limitation."

Abnormal Operating Condition – A situation in which Company is operating the Distribution System in other than normal configuration, or under conditions that do not normally exist.

Application – See Interconnection Request Application below.

Company – One of the following Southern Company operating subsidiaries: Alabama Power Company, Georgia Power Company, or Mississippi Power Company, which provides interconnection service to a DER.

Customer – An entity that receives electric service from Company.

Distributed Energy Resource (DER) – A source of electric power that is directly connected to Company's Distribution System. DER sources include Energy Storage Systems, fuel cells, solar photovoltaic (PV), biomass, natural gas, wind, etc. DER conversion technology includes inverters, induction generators, and synchronous generators, including reciprocating or turbine-driven generators.

DER Impact Study – A technical analysis to determine whether adverse effects to the operation or reliability of the Distribution system would be created as a result of the DER under study operating in parallel with the system at the proposed POI.

DER Owner – The entity that is the counterparty to Company in the DER Interconnection Agreement.

Distribution System – Company's wires, equipment, and facilities that operate at a nominal operating alternating current (AC) voltage of 34.5 kV or below.

Energy Storage System – A system that captures energy produced at one time, stores that energy for a period of time, and delivers that energy as electricity at a future time.

Interconnection – The physical connection of a DER to Company's Distribution System.

Interconnection Agreement – The contract between Company and DER Owner that stipulates terms and conditions for DER Interconnection and Parallel Operation.

Interconnection Equipment – Company-owned facilities that are required for DER interconnection service.

Interconnection Request Application ("Application") – Formal application to connect a DER to Company's Distribution System and for DER interconnection service, using Company's standard form.

Island – According to IEEE 1547-2018, a condition in which a portion of Company's Distribution System is energized solely by a DER while that portion is electrically separated from the rest of Company's electric

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system on all phases to which the DER is connected. IEEE defines both intentional and unintentional islands. Intentional islands may be desirable in some cases, such as in a microgrid that is planned to operate independently during a weather event or unforeseen outage. An unintentional island is not planned and is considered undesirable because line worker practices, protective equipment, and grid control systems are not designed for those conditions.

Letter of Credit – A standby letter of credit that is: (i) substantially in Company's standard form; (ii) issued by a U.S. commercial bank or a U.S. branch of a foreign bank with total assets of at least \$10 billion, having a general long-term senior unsecured debt rating of A minus or higher as rated by S&P, or A3 or higher as rated by Moody's, or A minus or higher as rated by Fitch; and (iii) otherwise acceptable to Company in Company's sole discretion.

Meter – A device or sensor that measures the amount of electricity consumed or generated by a DER. It may also be used to monitor the voltage, current, or other electrical characteristics of the electricity generated by a DER.

Network Secondary Distribution System – A Distribution System in which the secondary of multiple distribution transformers are connected to a common network for supplying electric power to customers.

Parallel Operation – Operation of a DER connected to Company's Distribution System.

Parent Guaranty – Guarantee by a parent company of an entity's performance under its contract with another party, where the entity is a subsidiary of the parent company.

Point of Interconnection (POI) – The point of connection of the DER to Company's Distribution System; this term is synonymous with point of common coupling (PCC) as used in IEEE 1547.

Power Delivered – Electricity supplied by Company to the DER .

Power Received – Electricity supplied by the DER to Company's Distribution System.

Technical Requirements – Company's *Technical Requirements for Distribution Interconnection*, attached as Attachment A, as updated and then-current, as well as the technical standards listed in Section 7.0 (*DER Design and Installation*).

Telemetry – Communications equipment used to obtain information from the DER or to control the DER, including a transmitter, antenna, pole for the antenna, telephone, etc.

Term – Time period during which terms and conditions of an Interconnection Agreement are binding.

Witness Testing – Live testing of the DER while operating in parallel with Company's Distribution System.

- 4.0 Limitations.** Where necessary, Company may limit the capacity and operating characteristics of the DER to avoid the potential of causing service or other reliability issues to other Customers. If Company concludes that an Application describes facilities that may require additional devices and operating schemes, Company will make those additional requirements and costs known to the DER Owner before DER Interconnection Agreement is executed.
- 5.0 Energy Storage.** Energy Storage Systems are controllable and capable of both injecting and withdrawing electricity from the Distribution System, as well as near-instantaneous ramp to full capacity in either charge or discharge mode. The incorporation of Energy Storage Systems onto the Distribution System may require additional study.
- 6.0 Insurance and Security.** Adequate insurance, as deemed by Company, may be required as part of the Interconnection Agreement. DER Owner must use reasonable care not to damage Company's electrical equipment and must reimburse Company for damage to any Company property resulting from defects in the operation or maintenance of DER Owner's electrical equipment or resulting from DER Owner's negligence or that of its employees, contractors, representatives, or agents. DER Owner also must indemnify Company against liability for injury or damage suffered by any third party arising from any such defect or negligence.
- 7.0 DER Design and Installation.** DER Owner is responsible for ensuring that DER design and installation meet technical requirements of Attachment A (Southern Company's *Technical Requirements for Distribution Interconnection*) and comply with, as applicable, the National Electrical Code (NEC), the

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National Electrical Safety Code (NESC), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers Association (NEMA), American National Standards Institute (ANSI), National Fire Protection Association (NFPA), Underwriters Laboratories (UL), Federal Aviation Administration (FAA), Federal Communications Commission (FCC), other national codes, standards, local codes, and any jurisdictional requirements pertaining to electrical facility design, construction, or safety.

Company reserves the right to field verify (or have an independent, qualified third party verify) the DER installed equipment against the equipment specified in the Application. Company's review of the Application, submitted design or equipment documents, or specifications; on-site verification or testing by Company; or Company's observation of tests by others are for the sole benefit of Company and are not an endorsement of the fitness of design, installation, or operation of the DER system or related equipment.

8.0 Interconnection Process. The DER interconnection process begins with formal submission of an Application by DER Owner and ends formally with either Company's express written consent or denial to DER parallel operation or DER Owner's express written withdrawal of the Application. The duration of the interconnection process can vary significantly, depending on several factors, including complexity of studies; timeliness and accuracy of data submission and the engineering design of the DER; and the engineering and construction of any Distribution System upgrade or modification identified during the study process. DER Owner is encouraged to consider a pre-application (per Section 8.1) and must recognize the interconnection process timeline in its project schedule.

8.1 Pre-Application Request. To assist DER Owners with DER sizing and site selection, DER Owners are encouraged to submit a pre-application request to Company, using the pre-application form in Attachment B and including the applicable non-refundable fee, to obtain readily available Company Distribution System data.

8.1.1 Pre-Application Report. If DER Owner elects to submit a pre-application request, Company will provide the following data within 15 business days after Company's receipt of the complete pre-application request:

- Nominal operating primary voltage, conductor rating and number of phases for the line section at the proposed POI; if single phase, distance to nearest three phase line;
- Approximate distance between proposed DER POI and the source substation from which circuit likely to serve the proposed DER ("Circuit") originates; and
- Rating of protective devices and type of voltage regulating devices between the proposed POI and the Circuit head.
- Most recent annual peak load measured at the Circuit head;
- Aggregate capacity of existing export DER on the Circuit

Pre-application data is non-binding. Due to the dynamic nature of Company's Distribution System, Company will not be liable if information in the report changes before DER Owner formally applies for interconnection service. The circuit identified in the pre-application report also may not be the circuit to which the DER may ultimately connect.

8.2 Application. Company will process Interconnection Request Applications on a first-come, first-served basis.

8.2.1 Application Package & Cost. Interconnection studies will be conducted only after all Application forms and related fees are submitted and determined to be complete. To avoid project delay, DER Owner must complete Application forms including Attachment C (*DER Technical Data*) and submit to the appropriate Company contact, along with all supporting documents and non-refundable processing fee, as applicable. All checks must be made payable to Company. All Application and pre-application fees are non-refundable.

Application Supporting Documents:

- | | |
|---|---|
| <ul style="list-style-type: none"> ▪ DER site plan showing proposed POI; ▪ DER one-line electrical diagram; ▪ DER relay and metering one-line; | <ul style="list-style-type: none"> ▪ Proof of DER site control in the form of a property tax bill, lease agreement, or other legally binding document. |
|---|---|

A registered Professional Engineer must stamp all drawings for DER above 100 kW. The relay and Metering one-line must show all interconnection protection functions specified in Attachment A (Southern Company's *Technical Requirements for Distribution Interconnection*). DER drawings must show only DER Owner equipment and a note indicating the POI.

8.2.2 Application Processing & Review. Upon receipt of the Application package, Company will acknowledge receipt, review the package for completeness, and determine if additional data is required. Timely response to an additional data request is necessary to avoid delay in Application processing. Failure of DER Owner to timely respond to an additional data request may lead to cancellation of the Application and forfeiture of the non-refundable Application fee.

8.2.3 DER Design Review. After determining the Application package to be complete, Company will review the Application package for compliance with the design requirements stipulated in Attachment A. Company may request a face-to-face meeting to review the one-lines with the DER Design Engineer. After reviewing the Application package, Company will advise DER Owner of any deficiency in meeting Company's Technical Requirements.

8.2.4 DER Site Visit. A site visit is intended for Company and DER Owner to jointly decide POI, proposed route for Company intertie line location, and location of Company's Interconnection Equipment in relation to DER equipment location. Since POI and DER size are material to the system impact studies, DER Owner should not change POI or DER size after the site visit. Any change in these items may result in Company's requirement for DER Owner to submit a revised Application.

8.3 Studies.

8.3.1 DER Impact Study & Cost. After the DER site visit, Company and DER Owner will jointly determine scope of all necessary DER Impact Studies. Studies will include assessment of parallel operation concerns described in Attachment A. For Company Distribution System circuits with normal open ties with other distribution circuits, DER Owner must decide if the adjacent circuit(s) should be included in the scope of DER impact studies. Once scope is agreed to, Company will prepare a DER system impact study proposal, including study cost, and provide to DER Owner for upfront payment prior to beginning the study. The study proposal will state the estimated time for Company to complete the study after receipt of payment and identify the applicable studies.

8.3.1.1 Affected System Study. An Affected System Study is analysis by another entity that may be affected by interconnection of the DER.

8.3.1.2 Protection System Study. Protection System Study is an engineering analysis that determines whether DER Interconnection and Parallel Operation would adversely impact coordination or reliability of Company's existing protection system(s) and scheme(s). It also includes a review of the fault current contribution by the DER and its effects on these protection system(s) and scheme(s).

8.3.1.3 Distribution System Study. Distribution System Study is an engineering analysis that determines whether DER Interconnection and Parallel Operation will adversely impact ability of the interconnecting distribution circuit to continue to provide reliable and adequate service to existing end-use Customers. This study includes a review of the DER contribution to power flow on the interconnecting circuit and effects on the magnitude and quality of the circuit voltage.

8.3.1.4 Network Study. Network Study is an engineering analysis that determines the amount of DER that can safely and reliably be added to a Network Secondary Distribution System.

8.3.1.5 Transmission System Study. Transmission System Study is an engineering analysis that models the DER impact to the transmission system.

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8.3.2 Study Refund Policy. Payment by the DER Owner for Impact Study cost should be paid prior to beginning the study and is non-refundable.

8.3.3 System Impact Study Report. Upon completion of DER Impact Study, Company will provide a system study report to the DER Owner. The report will describe study results, including any Company electric system modifications or upgrades upstream of proposed DER POI that are necessary to accommodate DER Interconnection and Parallel Operation. At the request of DER Owner, Company and DER Owner may meet to jointly review results of system study.

8.3.4 Commencement of DER Construction. At DER Owner's sole risk and discretion, DER Owner may commence DER equipment procurement, site preparation, and construction once the system impact study is completed.

8.4 Interconnection Equipment Study and Cost.

8.4.1 Interconnection Equipment Study. If DER Owner decides to proceed with DER construction project after review and acceptance of the system study report, and it is determined that Interconnection Equipment (including on-site facilities or upstream system upgrades) are needed for interconnection service, Company will estimate the cost to conduct an Interconnection Equipment study. Company will provide an Interconnection Equipment study cost proposal (including invoice) to DER Owner. The study cost proposal will include estimated time for Company to complete study after receipt of payment. DER Owner must pay within 20 business days of study cost invoice date to avoid delay. The refund policy of section 8.3.2 (*Study Refund Policy*) applies.

8.4.2 Interconnection Proposal. Upon completion of the Interconnection Equipment study, Company will provide a study report to the DER Owner. This report and interconnection proposal will provide estimated installation cost of the necessary Interconnection Equipment. Other costs, including tax impact and ongoing operations and maintenance, will also be provided, along with estimated number of business days required to complete installation and commissioning of Interconnection Equipment after receipt of DER Owner's Interconnection Equipment cost payment, equipment procurement, and Company's acquisition of all permits, easements, and rights-of-way.

Due to time sensitivity of labor and equipment costs, Company's interconnection proposal will be valid for 90 calendar days. During this time, the DER Owner must review the proposal and notify Company in writing of its acceptance, to avoid delay.

8.4.3 Interconnection Costs. The DER Owner must pay Company for all costs reasonably incurred by or on behalf of Company, including required system upgrades or Metering modifications in connection with Company's Interconnection Equipment required for interconnection service to the DER. In addition, the DER Owner may be required to provide financial security through a Letter of Credit, Parent Guaranty, or other form of security that is acceptable to Company, at its sole discretion.

8.5 Interconnection Agreement and Installation

8.5.1 Interconnection Agreement. If required, Company will prepare a draft Interconnection Agreement for DER Owner's review within three business days after receipt of DER Owner's acceptance of the interconnection proposal. DER Owner must also supply needed information required for preparation of the execution version of Interconnection Agreement. Once finalized, Company and DER Owner will sign the execution version of the Interconnection Agreement.

8.5.2 Interconnection Equipment Installation Cost Invoice. After notice to proceed, the Company will prepare and submit the invoice for Interconnection Equipment installation project cost to DER Owner. If DER Owner does not pay the invoice cost within 20 business days, Company will deem the interconnection request to be withdrawn.

8.5.3 Interconnection Equipment Installation Project. After receipt of payment of Interconnection Equipment installation cost, Company will begin procurement and installation of Interconnection Equipment and, if necessary, acquire permits (including railroad), easements, and rights-of-way for Interconnection Equipment installation. DER Owner must cooperate with Company in acquisition of easement, clearing, and preparation of route for Company tie line and

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Interconnection Equipment on the DER site. Company will install all sole use Interconnection Equipment.

8.6 DER Construction and Initial Synchronization

8.6.1 Commencement of DER Construction. If DER Owner has not previously commenced DER equipment procurement and construction, it may do so at any time after execution of the Interconnection Agreement.

8.6.2 Completion of DER Construction. Within 60 calendar days before completion of DER construction, DER Owner must provide the following DER data to Company:

- Manufacturer's certified test reports for each DER generator, each generator step-up transformer, and the DER interconnection transformers;
- DER one-line electrical & relay and Metering diagrams;
- DER AC three-line diagram showing the current and voltage circuits for all interconnection protection relay(s);
- DER interconnection power circuit breaker DC elementary, showing trip and close circuits; and
- Written description of various modes of operations of DER generators.

Company will compare this data to the original data DER Owner provided for the system impact study. If material differences are identified, DER Owner and Company will cooperate on revisions to the system study. DER Owner may incur additional cost for revisions to the system study.

8.6.3 DER Interconnection Protection Settings. If required, DER Owner and Company will cooperate in determining DER Interconnection protection settings. DER Owner will calculate these settings and provide to Company for review and acceptance.

8.6.4 Changes to DER. DER Owner must obtain Company's consent prior to making any proposed modifications to the DER.

8.6.5 Testing of Interconnection Protection & Control Schemes. After finalization of interconnection protection settings, Company may require the DER Owner to arrange for all settings (including logic to control interconnection breaker tripping and closing) to be applied to the interconnection protection and control devices and notify Company of completion of this activity. DER Owner and Company will then select a date and time during which Company personnel can observe the testing (including application of test voltage and current) of the interconnection protection and control devices. Testing will include injection of test voltage and current to the interconnection protection and control devices and tripping and closing (including automatic reclosing, if applicable) of the interconnection breaker.

8.6.6 DER Initial Synchronization. Following: (i) successful testing of the interconnection protection and control schemes; (ii) DER Owner's establishment or confirmation of a Company account; (iii) inspection of the DER by Authority Having Jurisdiction (AHJ); (iv) Company's receipt of a copy of the inspection certificate; and (v) if applicable, completion of another entity's necessary modifications, DER Owner will notify Company, at least 10 business days in advance, of the date and time of initial synchronization of the DER. If no AHJ exists for the DER location, the DER must be inspected by a qualified licensed electrician, registered Professional Engineer, or other person deemed qualified by Company.

DER Owner will be granted one 7-day period of Initial Synchronization. If the Initial Synchronization period exceeds 7 days, Company reserves the right to temporarily disconnect the DER per section 11.1(i) (*Temporary Disconnection*).

8.6.7 DER Witness Testing. Following confirmation by DER Owner that the DER initial synchronization, including proper configurations of controls (e.g., excitation, ride-through, start and stop permissive, etc.) for all DER generators are complete, Company and DER Owner will jointly decide date and time of DER Witness Testing in accordance with the Company Test Policy and any other unique test requirements developed for the DER.

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8.6.8 DER Parallel Operation Permission. After successful Witness Testing, Company will issue a final permission of DER Parallel Operation. If required, DER Owner and Company will jointly develop DER Operating Procedures and any amendment to the Interconnection Agreement.

9.0 DER Operations and Maintenance. The DER Owner is solely responsible for proper operation of the DER. The DER Owner may be required to maintain records of operation and maintenance activities, which Company may review at reasonable times. Maintenance records should be made available for Company's inspection upon request. Company reserves the right to inspect the records, but has no responsibility for maintenance, either actual or implied.

10.0 DER Periodic Witness Testing. Throughout the Term of the Interconnection Agreement (IA), the Company reserves the right to periodically assess the DER or conduct Witness Testing of the DER for compliance with the Interconnection Agreement. DER Owner must cooperate with the Company in the scheduling and performance of any periodic or other assessment or Witness Testing.

11.0 Disconnection and Curtailment

11.1 Temporary Disconnection. On a non-discriminatory basis, Company may temporarily disconnect the DER from Company's Distribution System:

- (i) During the DER Initial Synchronization, if the period of Initial Synchronization exceeds seven (7) days or after Initial Synchronization if DER testing is not successfully completed; or
- (ii) During an emergency (e.g., a situation imminently likely to endanger life or property); or
- (iii) On occurrence of one of the following, if the Company could reasonably expect that the event/condition could materially and adversely affect Company's Distribution System equipment or the safe and reliable operation of the Distribution System:
 - (iv) Noncompliant DER operation or output; or
 - (v) Hazardous condition, lack of scheduled maintenance or testing, or an operating characteristic revealed by DER assessment; or
 - (vi) Modification of DER equipment or interconnection protection and control device or scheme without Company approval; or
 - (vii) Tampering with, or unauthorized use of Company's Distribution System equipment; or
 - (viii) Failure of Distribution System equipment; or
 - (ix) Failure of DER, after reasonable notice, to curtail per section 11.2 (*Curtailment*)
- (x) For routine or emergency maintenance, repair, testing, modification, or replacement of the Distribution System, including manual or automatic Company Distribution System re-configuration that could result in the DER's interconnection with parts of the Distribution System that were not studied for parallel operation with the DER; or
- (xi) For DER Owner's failure to fulfill its payment or security obligations or for any other default under the Interconnection Agreement; or
- (xii) Under normal operation of protection and control devices or schemes.

11.2 Curtailment. If Company determines that the DER's continued operation at then-existing power output levels could affect Company's ability to safely and reliably operate and maintain Company's electric system, Company may require DER Owner to reduce DER power export to Company Distribution System.

11.3 Disconnection/Curtailment Notice. If a condition described in subparts (i) through (vi) of section 11.1 (*Temporary Disconnection*) or in Section 11.2 (*Curtailment*) occurs, and to the extent reasonably practicable under the circumstances, Company will notify DER Owner regarding the need to disconnect. DER Owner must disconnect or curtail immediately upon receipt of the notice. If circumstances do not permit advanced notice, Company may disconnect the DER without notice. Company will reconnect as soon as reasonably practicable after cure or termination of the event or condition. If applicable, Company and DER Owner will cooperate and coordinate to the extent necessary to restore the DER, Interconnection Equipment, and Company's Distribution System to the normal operating state.

- 11.4 Disconnection Expense.** DER Owner will reimburse (upon invoice) any costs Company incurs in connection with disconnection or reconnection arising from DER Owner's negligence (by act or omission), intentional wrongdoing, or default pursuant to the Interconnection Agreement.
- 12.0 Changes to Company Distribution System.** The Company Distribution System is a dynamic and changing system. Company reserves the right to modify or reconfigure the Distribution System as necessary to ensure safe and reliable operation of the System. The DER Owner will be responsible for paying for modifications required for reconnecting the DER to the Company's reconfigured Distribution System.
- 13.0 Energizing Dead Circuits.** The DER must not, in any circumstance, energize a de-energized Company Distribution Circuit without prior written permission from Company.

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Attachment A - Company Interconnection Requirements

Attachment B – DER Interconnection Pre-Application

Attachment C – DER Technical Data

Attachment D – Metering Arrangements

ATTACHMENT A

TECHNICAL REQUIREMENT FOR DISTRIBUTION INTERCONNECTION

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ATTACHMENT A

TECHNICAL REQUIREMENT FOR DISTRIBUTION INTERCONNECTION

1.0 Company Distribution System. The Company distribution system is generally designed for uni-directional flow of power from the transmission system to end-use customers that receive electric service from one of the following types of circuits (or feeders):

1.1 Radial Distribution Feeders. Radial distribution feeders are generally used to serve end-use customers via pole- or pad-mounted service transformer(s). Equipment for these feeders are typically installed overhead (on poles), underground or on a pad. Feeder topology includes three-phase (4-wire), two-phase (3-wire) and one-phase (2 wire) sections. One of the wires is a multi-grounded common-neutral.

To improve service reliability of customers served by radial distribution feeders, normal open ties may be established with adjacent feeders originating from the same or a different substation. The normal open ties are used to serve end-use customers from adjacent feeders in case the feeder used to normally serve these customers experiences an outage. The simple one-line diagram below shows two radial feeders from the same substation with a normal open (N.O.), motor-operated tie switch.

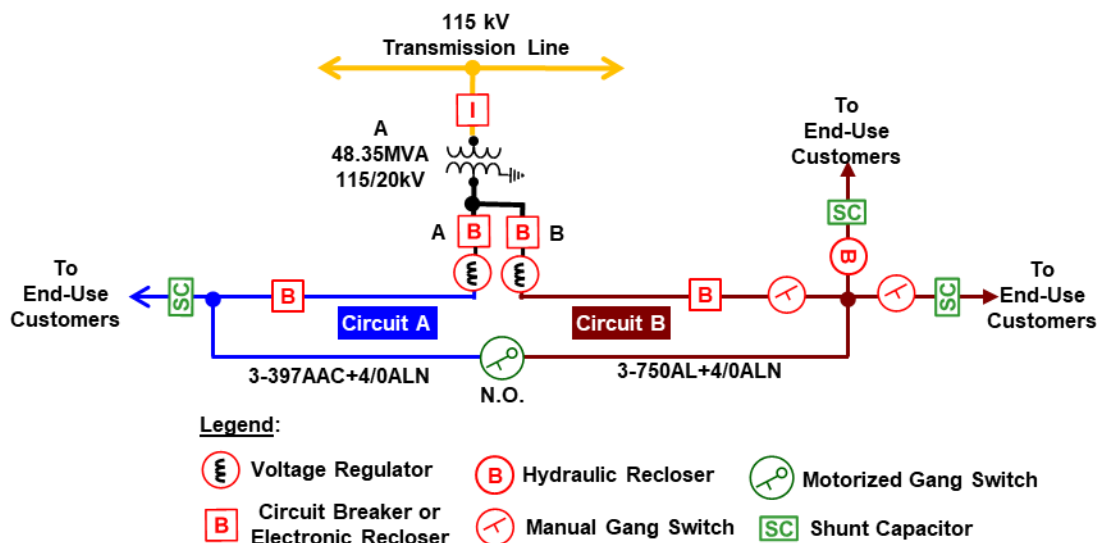


Figure 1 – Simple one-line diagram of two radial distribution feeders

Feeder faults are detected and cleared by overcurrent protective devices that are configured on the basis of fault current flow from the feeder head or source substation to the faulted equipment. Due to time-current coordination of these devices, the faulted portion of the feeder is isolated by the closest protective device to ensure the un-faulted portion continues to provide electric service to end-use customers.

Three-phase electrical service is provided either by one three-phase, grounded-wye/grounded-wye transformer, a bank of three single-phase transformers connected grounded-wye on both primary and secondary sides or a bank of two single-phase transformers connected open-delta. Company equipment, including substation load-tap changing transformers, substation class single-phase voltage regulators, line voltage regulators, and shunt capacitors are used to maintain service voltage to end-use customers within acceptable limits.

1.2 Secondary Networks. Secondary networks are generally used to serve end-use customers in major metropolitan areas. These networks can serve one or more end-use customers. A secondary network that serves more than one customer is called a Grid Network. A secondary network that

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serves only one customer is called a Spot Network. Grid network service voltage is typically 208GrdY/120V. Spot network service voltage is either 480GrdY/277V or 4160GrdY/2400V.

Feeders that supply secondary networks are usually installed underground in a manhole and duct system. The feeders are routed to ensure service continuity to the network load if one feeder is out of service. All feeders that supply a secondary network usually originate from the same substation. A load tap changing substation transformer provides voltage regulation for the secondary network customers.

All network transformers basically operate in parallel on the secondary side. Winding configuration for these transformers is typically delta primary, grounded-wye secondary. Each transformer connects to the secondary network via a network protector.

The network protector comprises a low voltage air circuit breaker, a reverse power relay (32), a voltage balance relay (60) that senses voltage on both sides of the breaker and a fuse.

The low voltage circuit breaker is equipped with a trip and close mechanism that is controlled by the reverse power and voltage balance relays. The reverse power relay initiates tripping of the breaker after a pre-determined time delay upon sensing current flow from the secondary network to the transformer and primary feeder. Current flow towards the transformer primary is abnormal and is possibly due to faults in the transformer or primary feeder. To detect primary feeder faults (especially ground faults) through the delta-connected primary windings of the network transformer, the pickup set-point for the reverse power relay is usually the network transformer core loss (which is typically less than 1% of the transformer kVA rating). The voltage balance relay initiates automatic closing of the breaker if:

- the magnitude of the voltage on the transformer side of the breaker is slightly higher than the voltage magnitude on the secondary network side; and
- the phase angle of the transformer side voltage leads the network side voltage.

The network protector fuse provides backup protection to the reverse power relay. The combination of the network transformer, the network protector and the fuse is called a Network Unit. A one-line diagram of a network unit is shown in Figure 2 below.

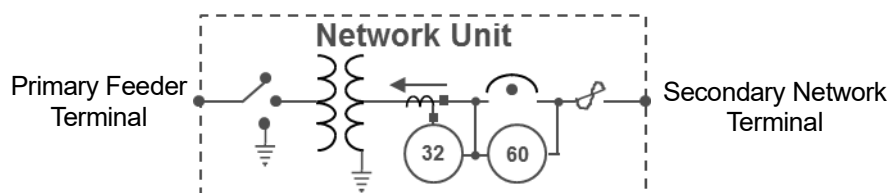


Figure 2 – Network Unit one-line

A sample one-line for a Grid Network is shown in Appendix A. One-line for Spot Network is similar except for the number of network units. A typical Spot Network will contain two to three network units to maintain N – 1 contingency.

2.0 Company Distribution System Frequency. Alternating current frequency of the Company distribution system is 60 Hz.

3.0 Primary Distribution System Voltages. Voltage class and nominal operating voltage magnitudes of the Company primary distribution system are listed below in Table 1. Prospective DER Owners should contact the Company for specific system nominal operating voltage at the DER proposed point of interconnection (POI) prior to designing the DER especially if the DER Owner is permitted to own the interconnection transformer.

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Table 1 – Company primary distribution system voltages

Voltage Class	Nominal Operating Voltage Magnitudes (Phase to Phase)
5 kV	4.16 kV
15 kV	8.32 kV, 12.47 kV, 13.2 kV, 13.8 kV
27 kV	19.8 kV, 22.86 kV, 24.94 kV
35 kV	34.5 kV

4.0 Secondary Distribution System Voltages. The nominal secondary operating voltage of the Company distribution system is listed below.

Table 2 – Company secondary distribution system voltages

Service Type	Nominal Operating Voltage Magnitudes
Single Phase	120/240V 3-Wire
Three Phase	240V Delta 3-Wire, 208GrdY/120V 4-Wire, 480GrdY/277V 4-Wire, 480V Delta 3-Wire

Note:

Three-phase, 3-wire delta service is only provided by a set of three single-phase, pole-mounted transformers. These transformers range in size from 15 kVA to 500 kVA.

5.0 Issues of Concern with DER Parallel Operation. The five major issues with parallel operation of DER on the Company distribution system are:

5.1 Unintentional Island. An unintentional island is an unplanned island that can cause:

- a) safety hazard for Company workers and the public;
- b) unacceptable quality of service to end-use customers since DER may not be capable of providing appropriate service voltage and frequency; and
- c) potential damage to Company facilities and/or end-use customer equipment.

5.2 Equipment Ratings. Short-circuit interrupting rating of protection equipment installed on the Company radial distribution feeders ranges from 875 Amps to 12,500 Amps at the primary voltage level. Short circuit rating of Company owned equipment (especially pad-mounted service equipment elbows or load-break connectors with fault close rating of 10,000 Amps) can be exceeded depending on DER size and POI. Therefore, to ensure design ratings of Company equipment will not be exceeded, the Company reserves the right to limit the total amount of DER that can operate in parallel with distribution feeders that provide electric service to end-use

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customers, absent customer-funded upgrades to Company facilities deemed necessary to accommodate the DER. This helps ensure electric service to these customers will not be adversely impacted.

Specifically, for secondary network systems, parallel operation of DER may cause all of the network protectors to open especially under minimum loading condition. With one side of the network protector energized by the Company distribution system and the other side energized by the DER, the voltage across the open network protector can exceed its withstand rating. Additionally, if the DER is a rotating machine or can be considered a voltage source, the network protector may catastrophically fail if it closes out of phase. The network protector can also fail if it attempts to separate two dynamic systems. Finally, voltage balance relay of a network protector is not capable of synchronizing two dynamic systems.

5.3 Voltage Regulation. Per section 1.1 (*Radial Distribution Feeders*) and section 1.2 (*Secondary Networks*), Company distribution system voltage is regulated by Company equipment such as automatic load-tap changing transformers and single-phase voltage regulators at the feeder head or substation, line voltage regulators and switched shunt capacitor banks. Proper operation of these devices assumes one-way power flow from the substation to the system load. DER that operate in parallel with the Company distribution system can affect the proper operation of these voltage regulating devices by altering system power flow or voltage magnitudes. Therefore, to ensure electric service provided by the Company to its customers is not adversely impacted, parallel operation of DER with the Company distribution system shall not cause the system voltage at any location to go outside the limits specified below in Table 3:

Table 3 – Company electric service type and voltage range

Service Type	Voltage Range (% of Nominal)
Primary	$105\% \geq V \geq 97\%$
Secondary	$105\% \geq V \geq 95\%$

5.4 System Protection. Parallel operation of DER with the Company distribution system presents the following protection challenges. For faults on the system, the DER becomes a second source. By contributing current to the fault, the DER could cause desensitization of existing overcurrent protection devices.

5.5 Power Quality. Power quality concerns associated with DER parallel operations include:

5.5.1 Current Distortion. Harmonic current injected into the Company distribution system from DER may cause distortion of electric service voltage to end-use Customers, overheating of the DER interconnection transformer and interference with communication circuits.

5.5.2 Instantaneous Overvoltage. Overvoltage can result from ground faults on the Company distribution system that are fed solely by a DER that is not effectively grounded especially if the isolated area does not have enough load to cause immediate shutdown of the DER. For this situation of small load compared to DER size, extended trip time of the DER can also cause load rejection overvoltage.

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5.5.3 Rapid Voltage Changes. Quick transitions in the Company distribution system voltage can be caused by such events as the startup or shutdown of the DER, energization of a DER interconnection transformer, and switching of DER capacitor banks. Such rapid changes in Company distribution system voltage can result in light flicker for end-use Customers and excessive operations of Company distribution voltage regulation equipment.

5.5.4 Flicker. Flicker is the subjective impression of fluctuating luminance caused by voltage changes over a period of time, even if individual changes are not observed. Most properly functioning DER are not expected to produce pulsating power outputs that cause flicker complaints. However, flicker measurement (as defined in IEC 61000-4-15) and analysis has proven useful in differentiating when a site is not functioning properly.

6.0 DER Design and Operating Requirements. The DER must be designed with the following capabilities.

6.1 Ramp Rate Control. Unless otherwise stated in the DER Agreement or interconnection study report, the start-up (or enter service) ramp rate for the power output of a DER must be 10% per minute for a total duration of 10 minutes. For energy storage (ES) DERs that receive charging power from the Company electric system, the rate of charging will be specified in the interconnection study report. If interconnection study is not required for an ES DER, ramp rate, as specified above for power output will apply to the charging rate.

6.2 Real Power Curtailment. DER must be capable of limiting the amount of real power export to, or real power import from, the Company distribution system by a fixed percentage of installed capacity. Real power curtailment may be needed during times when the Company distribution system is automatically reconfigured due to operation of the Company fault location isolation and service restoration (FLISR) and automatic transfer scheme, which results in provision of interconnection service to the DER by an alternate distribution feeder that was not included in the original scope of system impact study for the DER. Another use case for this capability involves continuation of interconnection service to the DER at reduced output until repairs can be made to a failed piece of Company interconnection equipment (for example, tie line protective device that can be bypassed or communications line that is part of a communications-aided protection scheme) that Company deems material to accommodation of full output of the DER.

6.3 Reactive Power Control Capability. DER must be capable of operating between 90% power factor leading (or reactive power absorbing) and 90% power factor lagging (or reactive power producing). In addition, DER must have the following reactive power control capabilities.

The specific control the Company will specify for the DER will be based on results of a system impact study. DER that do not require detailed load flow study will be required to operate at 100% constant power factor, unless the feeder performance requires an alternate setting. As the Company distribution system changes during the Term of the Interconnection Agreement, the Company may require changes in reactive power control. Regardless of control mode, the DER must not cause the Company distribution system voltage at any location to go outside the limits provided in Section 5.3 (*Voltage Regulation*).

6.3.1 Constant Power Factor. For this control, the DER operates at a constant power factor that will be determined by the Company based on results of a system impact study.

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The required operating power factor will be within the range specified in section 6.3 (*Reactive Power Capability*).

- 6.3.2 Volt-Var.** For this advanced control, the DER actively controls its reactive power output in response to the voltage at POI on the Company distribution system based on the curves shown below. Figure 3 shows volt-var characteristic curve for DER with POI at the primary voltage level. Figure 4 shows volt-var characteristic curve for DER with POI at the secondary voltage level. Primary voltage level interconnections may require voltage sensors. Cost of these sensors will be borne by the DER Owner.

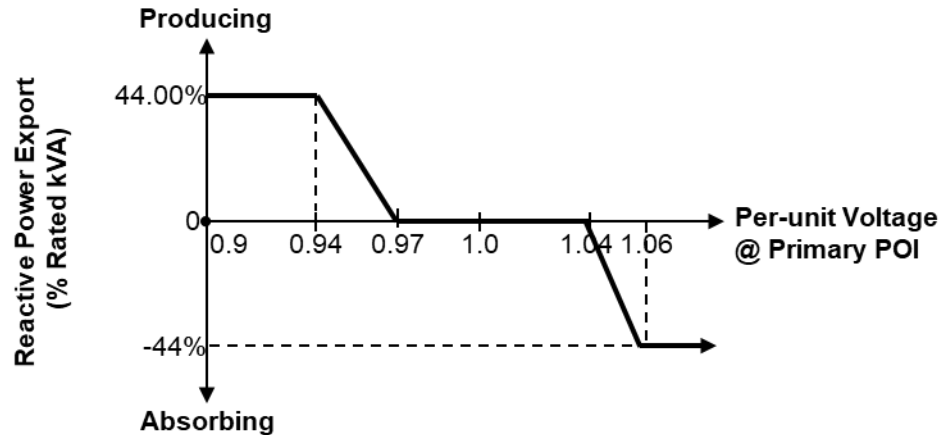


Figure 3 – Volt-Var requirement for DER with POI at primary voltage level

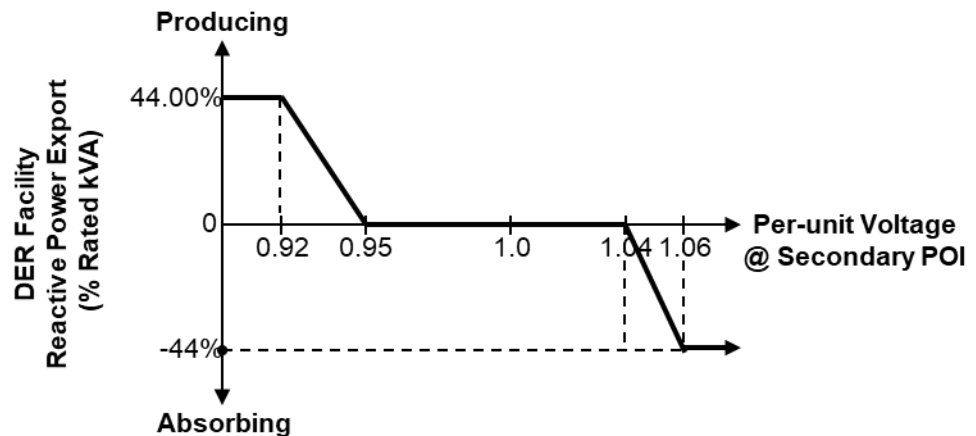


Figure 4 – Volt-Var requirement for DER with POI at secondary voltage level

- 6.3.3 Watt-Var.** For this advanced control, the DER actively controls reactive power output as a function of active power output based on the curve shown below in Figure 5.

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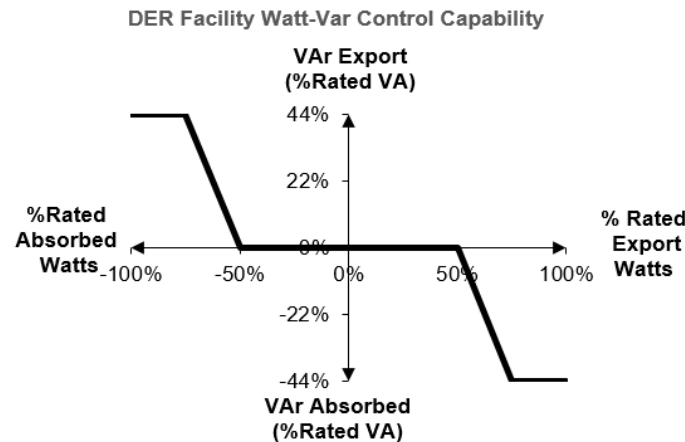


Figure 5 – Watt-Var requirement for DER

6.3.4 Constant Reactive Power. In this mode, the DER produces a constant reactive power.

6.4 Real Power Control (Volt-Watt). In addition to the reactive power control modes mentioned above, the DER must also have the capability of automatically adjusting its real power output in response to the Company distribution system voltage at the POI based on the characteristic curve shown below in Figure 6.

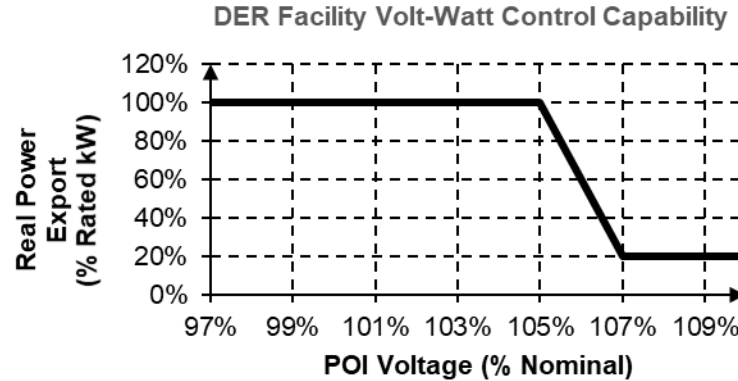


Figure 6 – Volt-Watt requirement for DER

6.5 Abnormal Voltage and Frequency Ride-Through Capability. Energy conversion equipment (e.g., generators and inverters) at the DER must be capable of meeting voltage ride-through requirements of abnormal operating performance Category I, if equipment is rotating machine, or Category III, if equipment is an inverter. IEEE 1547-2018 Table 14 (or Figure H.7) shall apply for Category I rotating machine DERs. IEEE 1547-2018 Table 16 (or Figure H.1 of IEEE 1547a-2020) shall apply for inverter-based DERs. All DERs shall meet frequency ride-through requirements described in IEEE 1547-2018 Table 18 (or Figure H.10).

6.5.1 Exemption for standby and emergency DER. Per IEEE 1547-2018 Clause 4.13, ride-through is not required for standby and emergency DER that operate in parallel with the Company electric system for longer than 100 ms.

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- 6.6 Power Quality.** The DER must comply with the ***Southern Company Power Quality Policy*** and meet transient overvoltage limits specified in Figure 3 of IEEE 1547-2018. Failure to comply with these requirements may result in immediate disconnection; reconnection cannot occur until DER Owner/Operator proves, to the Company's reasonable satisfaction, that the power quality problem (e.g., flicker or harmonics, as applicable) is corrected.
- 6.7 Radio Frequency Interference.** DER Owner/Operator must operate all equipment capable of generating radio frequency energy in compliance with, and in no event allowing its equipment to cause harmful interference as prohibited by, Section 15.5 of the FCC Rules. The Company and DER Owner/Operator will reasonably cooperate to identify the source of any allegedly harmful interference; however, DER Owner is solely responsible for promptly eliminating any harmful interference caused by DER Owner's equipment. Failure to comply with this provision may result in immediate disconnection; reconnection cannot occur until DER Owner proves, to Company's reasonable satisfaction, that the interference caused by DER Owner's equipment is corrected.
- 7.0 General Interconnection Protection Requirements.** Requirements below are minimum for most DER interconnections. Additional requirements may be required by Company in its sole determination. DER Owner/Operator is solely responsible for protecting the DER in such a manner that an outage, short circuit, or other disturbance on the Company distribution system does not damage DER equipment. Company has no responsibility or liability for any damage resulting from one of these, or any other, system condition.
- 7.1 DER Tie Line Protection.** DER with capability of exporting at least 1 MW of real power to the Company electric system will require, at DER Owner's expense, a tie line recloser with microprocessor-based protection and control relay. Tie line protective device for DER with export capability under 1 MW will generally be fused disconnect switch(es) unless system protection impact study identifies need for a different device.
- 7.2 Isolation (or Isolating) Switch.** DER must have a visible break and lockable disconnecting means in a location that is readily accessible to Company personnel. Company reserves the right to open the disconnecting means without prior notice to the DER Owner. Company also reserves the right to waive this requirement for DER with self-contained interchange meter.
- 7.3 Unintentional Islanding.** DER must not energize a de-energized Company electric system. DER Owner must provide and maintain, at DER Owner's expense, protection to prevent inadvertent energization of the Company electric system. The protection may include a communications link between the DER and the Company electric system.
- 7.4 Direct Transfer Trip.** Direct transfer trip (DTT) may be required to prevent unintentional islands, to prevent load-rejection TOV and to clear Company distribution system faults that may not be detectable by the DER interconnection protection scheme. Need for DTT will be evaluated in the DER interconnection request study.
- 7.5 Abnormal Voltage and Frequency Protection.** The DER must automatically disconnect from the Company electric system within the times prescribed below in Table 5, based on the voltage and frequency measured at the Point of Interconnection for each phase of the Company electric system the DER is interconnected with. If the DER fails to disconnect, creating a hazardous condition on the Company electric system, DER Owner is liable for resulting injury or damage to all facilities connected to the system.

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Table 5 – DER Shall Trip Settings for Abnormal Voltages & Frequencies

Voltage Protection Function	Pickup (p. u. of nominal voltage)	Clearing time (s)	Frequency Protection Function	Pickup (Hz)	Clearing time (s)
59-2	1.20	0.16	81O-2	62.0	0.16
59-1	1.10	1.0	81O-1	61.2	300
27-1	0.88	2.0	81U-1	58.5	300
27-2	0.50	0.16	81U-2	56.5	0.16

7.6 Current Transformers for Interconnection Protection. Current transformers (CTs) that supply interconnection protection relays must have minimum accuracy class of C200 and meet requirements of ANSI/IEEE Std C57.13 (*IEEE Standard Requirements for Instrument Transformers*). The secondary circuits for the CTs shall be continuous and be dedicated for the interconnection protection. Test switches (like the ABB Type FT-1 Switches) with make-before-break current short circuit feature can be installed in these circuits to facilitate relay system testing and maintenance.

7.7 Voltage Transformers for Interconnection Protection. Voltage transformers (VTs) that supply interconnection protection relays shall have a minimum thermal burden rating of 75 VA and meet requirements of ANSI/IEEE Std C57.13 (*IEEE Standard Requirements for Instrument Transformers*).

7.8 Interconnection Breaker Trip Energy Source. Direct current (DC) energy source from a battery is required. Means of monitoring health of this energy source must be provided. Loss of interconnection breaker trip energy source must result in immediate shutdown of DER energy conversion equipment.

7.9 DER Synchronization. DER Owner must provide, at DER Owner's expense, devices to synchronize the DER to the Electric System. Company equipment cannot be used for synchronization of the DER.

7.10 DER Reconnection to Company Electric System. Following any trip operation (or disconnection from the Company Electric System), the DER must wait for the utility voltage and frequency at the POI to return to and stay within the range specified below continuously for 5 minutes before reconnecting to the electric system:

$$91.7\% \text{ of nominal} \leq \text{POI Voltage} \leq 105\% \text{ of nominal};$$

$$59.5 \text{ Hz} \leq \text{POI Frequency} \leq 60.1 \text{ Hz}$$

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8.0 Inverter-Based DER Interconnection Requirements for Radial Feeders. Requirements below apply to inverter-based DER that operates or will operate in parallel with a radial distribution feeder.

8.1 Inverter Design Requirements. Inverter(s) must: (i) be utility-interactive (or grid connected / grid tie / grid following); (ii) be UL Listed; (iii) meet utility compatibility requirements of UL Standard 1741; (iv) meet protection requirements of Section 7.5 (*Abnormal Voltage and Frequency Protection*); (v) be capable of detecting and tripping for faults on the Company side of the DER intertie (or step-up) transformer; and (vi) meet the transient over-voltage requirements specified in section 6.8 (*Power Quality Design Requirements*). If DER uses inverters that do not meet any of the above requirements, the requirements of Section 10.0 (*Non-Inverter-Based DER*) shall apply.

8.2 Interconnection Transformer Winding Configurations. Interconnection transformer with grounded-wye windings on the Company side and grounded-wye windings on the DER side with no delta tertiary windings is required for three-phase DER interconnection. These winding configurations minimize interconnection protection requirements. Appendix B provides other winding configurations including pros and cons.

8.3 Detection of Company electric system faults. For interconnection winding configuration mentioned in Section 8.2 (*Interconnection Transformer Winding Configurations*) above, electric system faults will be detected and cleared by the inverter on-board voltage and frequency protection functions specified in section 7.5 (*Abnormal Voltage and Frequency Protection*) unless manufacturer of the DER inverter(s) confirms inhibition of on-board protection and unintentional islanding functions if advanced inverter functions mentioned in section 6.4.2 for Volt-Var control and section 6.6 for ride-through are enabled, in which case additional protection requirements (including DTT, a power circuit breaker with fault detecting relays or an electronic recloser) may be required at DER Owner's expense. These requirements will apply for all other winding configurations (especially grounded-wye Company side and delta DER side which forms a source of ground fault currents).

8.4 Detection of DER system faults. DER Owner will determine the protection equipment necessary to detect and clear DER system faults. DER Owner is responsible for coordinating DER overcurrent protection with the Company tie line overcurrent protection.

Appendix C Figure C1 shows a sample one-line for inverter-based DER 1 MVA or higher with a Company-owned grounded-wye/grounded-wye interconnection transformer. Appendix C Figure C2 shows a sample one-line with a non-Company-owned delta/grounded-wye interconnection transformer.

9.0 Inverter-Based DER Interconnection Requirements for Secondary Networks. Section 8.1 (*Inverter Design Requirements*), 8.3 (*Detection of Company electric system faults*) and 8.4 (*Detection of DER system faults*) shall apply for secondary network interconnections. In addition, DER design may include a special protection and control scheme to prevent opening of network protector(s) that serve other end-use Customers. Requirements of the scheme will be specified in the interconnection study report. One example of this scheme is shown in Appendix A.

10.0 Non-Inverter-Based DER Interconnection Requirements for Radial Feeders. Requirements below apply to DER that uses rotating machines like synchronous generators, induction generators, or inverters that do not meet requirements specified in Section 8.1 (*Inverter Design Requirements*). For parallel operation with a radial distribution feeder, DER Owner must install, at DER Owner's expense, an interconnection breaker that can be tripped by protection functions specified in Section 10.2

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(*Detection of DER system faults*) and Section 10.3 (*Detection of Company electric system faults*). In addition, if the DER is determined, through interconnection study, to be capable of creating an unintentional island, protection specified in Section 7.3 (*Unintentional Islanding*) applies.

10.1 Interconnection Transformer Winding Configurations. Generally, Company prefers interconnection transformer with grounded-wye windings on the Company side since this winding configuration is compatible with the Company's 4-wire, multi-grounded neutral distribution system. Winding configuration on the DER side is generally specified by the manufacturer of the DER energy conversion equipment. Prior to submitting DER one-line diagram as part of the interconnection request, DER Owner should seek guidance from the DER energy conversion device manufacturer. Generally, most synchronous generator manufacturer will prefer delta connected windings on the DER side for isolation of zero sequence circuits of the DER from zero sequence circuit of the Company distribution system. Appendix B provides other winding configurations including pros and cons.

Sample one-line for a non-inverter-based DER with delta-grounded-wye interconnection transformer is provided in Appendix C Figure C3 for illustration only.

10.2 Detection of Company electric system faults. Minimum protection functions required for the DER to detect and clear Company electric system faults include:

- a) Voltage (27/59) and frequency (81O/U) protection functions specified in Section 7.5 (*Abnormal Voltage and Frequency Protection*)
- b) Directional time and instantaneous phase-overcurrent (67); and
- c) Directional time and instantaneous ground-overcurrent (67N).
- d) These functions trip the interconnection breaker directly. If protection coordination study reveals that the overcurrent elements cannot be set to detect 25-ohm ground faults on the electric system, a DTT scheme will be required, at DER Owner's expense. DTT will also be required to prevent formation of unintended islands if the ratio of aggregate DER capacity to minimum load on any line section is greater than 1/3.

10.3 Detection of DER system faults. DER Owner will determine the protection equipment necessary to detect and clear all DER system faults. DER Owner is responsible for coordinating DER overcurrent protection for detection and clearing of DER system faults with the Company tie line overcurrent protection. These functions initiate tripping of the interconnection breaker via a manual-reset, lockout relay (86U). The lockout relay trips and blocks manual close and automatic reclose, if applicable, of the interconnection breaker. If overcurrent functions of this Section 10.3 and Section 10.2 (*Detection of Company electric system faults*) are contained in one multi-function, solid state relay, additional design requirements mentioned in Section 10.4 (*Multi-function Solid State Interconnection Relay*) apply.

10.4 Multi-function Solid State Interconnection Relay. Protection functions for detection of DER faults and Company electric system faults can be provided either by discrete relays or by a multi-function, solid state protective relay. If DER Owner chooses to use a multi-function, solid state protective relay, configuration of the relay must accomplish the following:

- a) All functions that detect Company electric system faults per section 10.2 (*Detection of Company electric system faults*) must initiate tripping of the interconnection breaker via a dedicated output contact. This output contact cannot be used by any other protection function.

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- b) All functions that detect DER faults per Section 10.3 (*Detection of DER faults*) must initiate tripping via a separate, dedicated output contact. This contact cannot be used by any other protection function. It must be wired to operate the manual-reset, lockout relay (86U) mentioned in Section 10.3 (*Detection of DER system faults*).
- c) The relay must be programmed to display a trip target for each interconnection protection function.
- d) If a pistol-grip control switch is used for manual close and trip of the interconnection breaker, trip and close contact from this switch must be wired to two separate inputs of the relay to ensure the solid-state relay supervises all trip and close commands to the interconnection breaker. A manual trip will then drive the automatic reclose (79) function of the relay to lockout, if this function is enabled.
- e) The power failure output contact of the relay must be monitored. A sequence of events report must be initiated upon detection of relay power failure. This report must be made available to the Company upon request. Additionally, this condition will also initiate operation of the lockout relay mentioned in Section 10.4 (*Interconnection Breaker Failure*).

10.5 Interconnection Breaker Failure. Failure of the interconnection breaker must initiate tripping and lockout of all DER synchronizing breakers via a manual-reset, lockout relay (86BF). This lockout relay trips and blocks closing of all synchronizing breakers.

10.6 Interconnection Breaker Trip Circuit Monitor. A red light to indicate close position of interconnection breaker is required. This light must be wired to monitor the breaker trip coil.

10.7 Protection from Automatic Reclosing of Company Equipment. Company normally applies automatic reclosing after fault clearing on all transmission and distribution circuits. The automatic reclosing schemes assume that the circuit is not energized and may not employ any voltage check, phasing, or synchronization scheme. DER Owner must ensure that the DER is disconnected from the Electric System prior to such automatic reclosing. Company has no responsibility or liability for damage to the DER equipment due to out-of-phase reclosing.

11.0 Non-Inverter-Based DER Interconnection Requirements for Secondary Networks. Generally, given concerns raised in Section 5.2 (*Equipment Ratings*), interconnection of voltage-source, non-inverter-based DER to Grid Networks will not be permitted. Requirements for current-source, non-inverter-based DER interconnection to Secondary Networks will be specified in the interconnection study report.

12.0 DER Interchange Metering Requirements. Company will install, at DER Owner's expense, appropriate interchange metering equipment for purchase of DER output and, if applicable, for sale, per applicable tariff, of DER station service. Generally, DER with capability of exporting at least 250 kW of real power to the Company electric system will require interval recording interchange metering equipment.

13.0 Monitoring, Information & Control Requirements. DER must have a local communications interface that supports DER information exchange with, and DER control, by the Company.

13.1 Communications Protocol. DER communications interface must support Distributed Network Protocol (DNP3), SunSpec Modbus, Smart Energy Profile 2.0 (SEP2) or IEC 61850.

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Protocol converter necessary to connect to the Company Supervisory Control and Data Acquisition (SCADA) system may be required at DER Owner's expense.

- 13.2 Information Exchange Requirements.** Information that the Company may require from the DER include energy conversion equipment quantity, type, nameplate data, reactive power control settings, active power control settings, In-service enabled/disabled settings, state of charge of ES DER, connection status, etc.
- 13.3 Control Requirements.** Local communications interface must support the Company's ability to remotely shut off all energy conversion equipment of the DER and remotely change the reactive power control setting of the DER (e.g., from 100% constant power factor to 95% constant power factor leading under certain Company system configuration). To support this objective, a power plant controller may be required at DER Owner's expense for a DER with more than one energy conversion device.
- 13.4 Exemption for Standby and Emergency DER.** Per IEEE 1547-2018 Clause 4.13, monitoring, information & control are not required for standby and emergency DER that operate in parallel with the Company electric system for longer than 100 ms.

ATTACHMENT A
TECHNICAL REQUIREMENT FOR DISTRIBUTION INTERCONNECTION

14.0 References

If a reference is undated, the latest edition of the referenced document applies.

American National Standard C2, National Electrical Safety Code (NESC)

NFPA 70, National Electrical Code (NEC)

IEEE 1547-2018, IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

IEEE Std 1547a-2020, Amendment I to IEEE 1547-2018 (To Provide More Flexibility for Adoption of Abnormal Operating Performance Category III)

IEEE 1547.1-2020, IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Energy Resources with Electric Power Systems and Associated Interfaces

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

UL 1741 Supplement SA – Grid Support Utility Interactive Inverters and Converters

Placeholder - UL 1741 Supplement SB For 1547-2018 Compliant Inverters and Converters

ANSI C84.1, Electric Power Systems and Equipment – Voltage Ratings

IEEE C62.92.1, IEEE Guide for the Application of Neutral Grounding in Electric Utility Systems

IEEE Std C57.12.44, IEEE Standard Requirements for Secondary Network Protectors

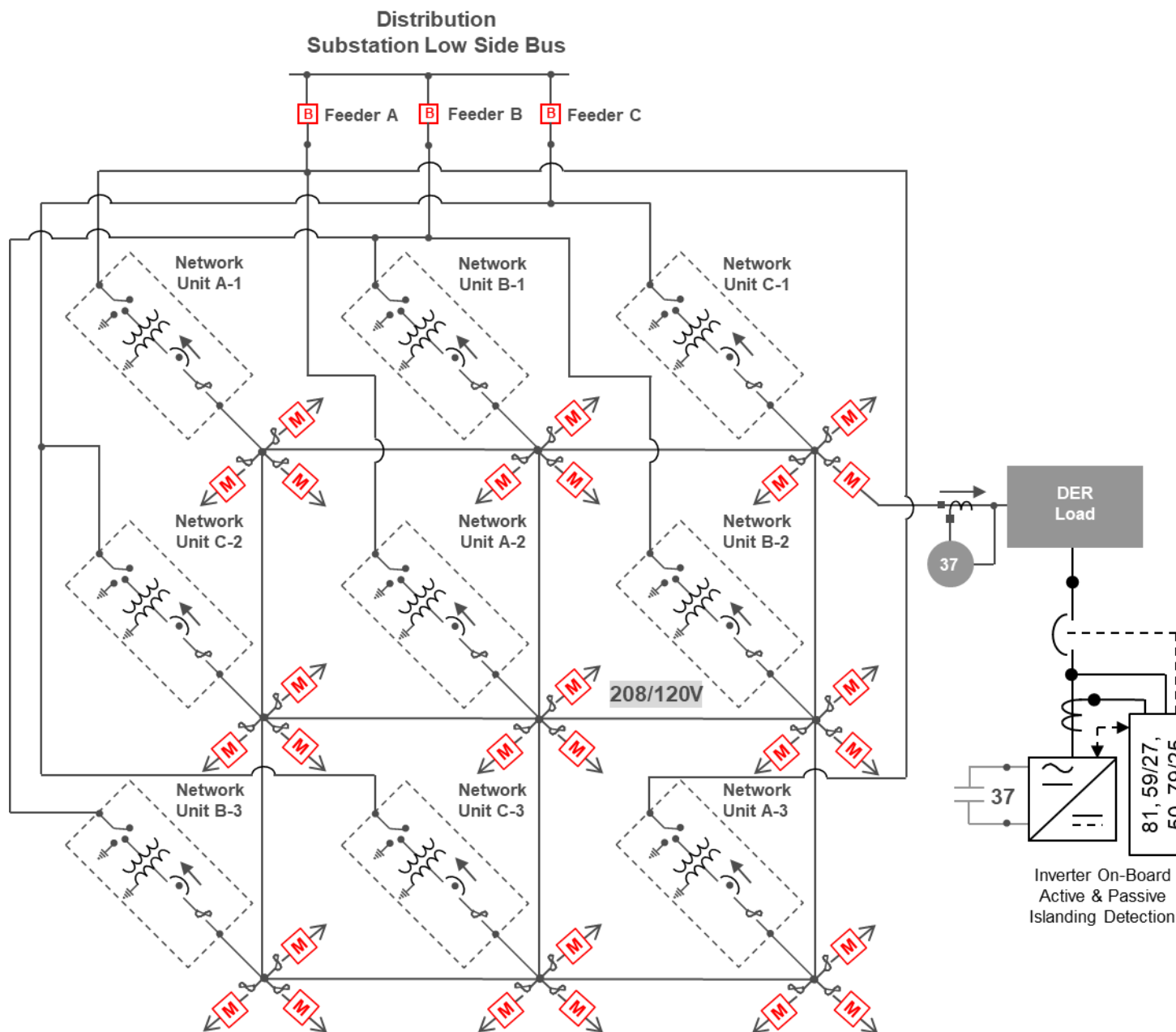
IEEE Std C37.108, IEEE Guide for Protection of Network Transformers

IEEE Std C57.13, IEEE Standard Requirements for Instrument Transformers

ATTACHMENT A

TECHNICAL REQUIREMENT FOR DISTRIBUTION INTERCONNECTION

Appendix A - DER Interconnection Example One-Line for Grid Network



Note:

Minimum import relay 37 permits inverter to turn on when DER load exceeds a certain percentage of the inverter rating and initiates inverter shutdown when DER load drops below a certain percentage of the inverter rating. This minimum import scheme maintains forward power flow from the network to the DER.

ATTACHMENT A

TECHNICAL REQUIREMENT FOR DISTRIBUTION INTERCONNECTION

Appendix B - DER Interconnection Transformer Winding Configurations

Figure B1 below shows various transformer winding configurations for interconnection service to a three-phase DER. Advantages and disadvantages of each type are provided in Table B1 also for guidance only. When the transformer is owned by the DER Owner, DER Owner must provide transformer winding configuration information and modeling data to the Company for protection system impact and coordination studies and determination of appropriate interconnection protection requirements.

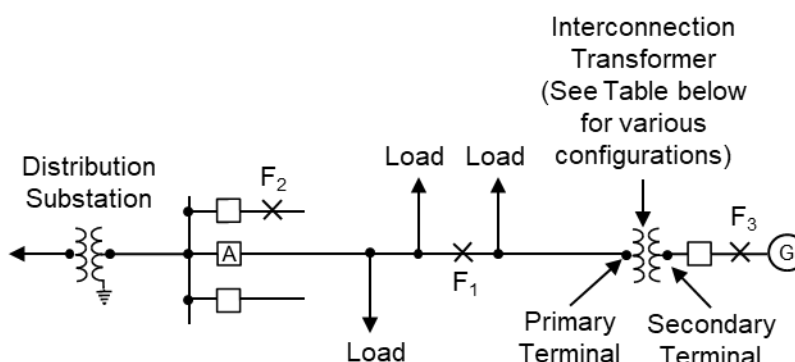
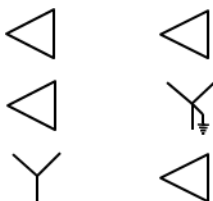




Figure B1 – Simple one-line of DER connection.

Table B1 – Various winding configurations of a three-phase interconnection transformer including advantages and disadvantages

Interconnection Transformer Winding Configuration Primary Secondary	Problems/Disadvantages	Advantages
	Can supply Company distribution circuit from an ungrounded source after substation breaker A trips causing overvoltage.	Provides no ground fault back-feed for fault at F ₁ & F ₂ . No ground current from breaker A for a fault at F ₃ .
	Provides an unwanted ground current for Company distribution circuit faults at F ₁ and F ₂ and reduces ground current at breaker A for restricted faults at F ₁ .	No ground current from Breaker A for faults at F ₃ . No overvoltage for ground fault at F ₁ .
	Allows Company distribution circuit relaying at Breaker A to respond to a secondary ground fault at F ₃ .	No overvoltage for ground fault at F ₁ .

Source: Mozina, Charles J., "Interconnect Protection of Dispersed Generators," 2001 IEEE/PES Transmission and Distribution Conference and Exposition, Atlanta, GA, November 2001

ATTACHMENT A

TECHNICAL REQUIREMENT FOR DISTRIBUTION INTERCONNECTION

Appendix C - DER Interconnection Sample One-Lines for Radial Distribution Feeders

Figures below show typical interconnection equipment for inverter-based and non-inverter-based DER. To facilitate control of energy conversion equipment, a power plant controller may be required for Facilities with multiple energy conversion equipment.

Figure C1 – Typical Inverter-Based DER 1 MVA or higher interconnection with Company owned grounded-wye/ grounded-wye interconnection transformer.

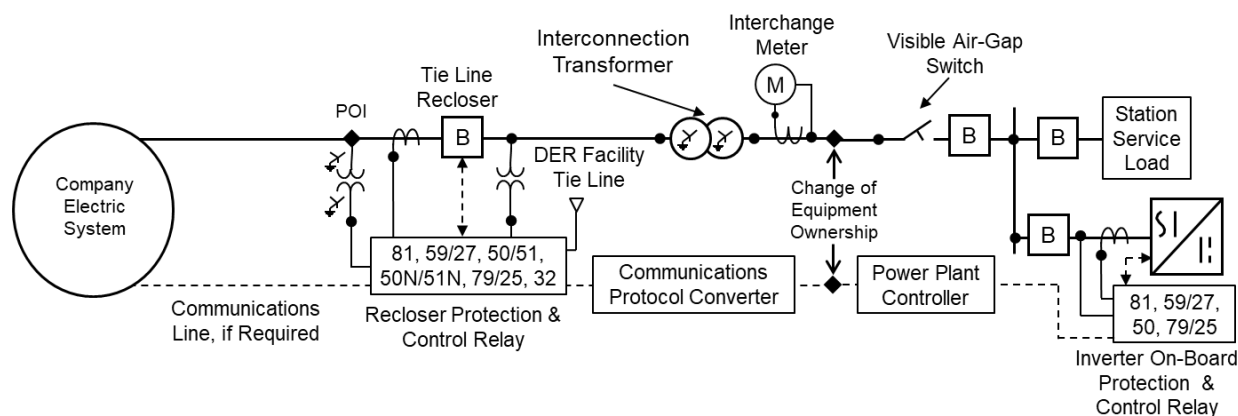


Figure C2 – Typical Inverter-Based DER interconnection with non-Company owned delta/ grounded-wye interconnection transformer.

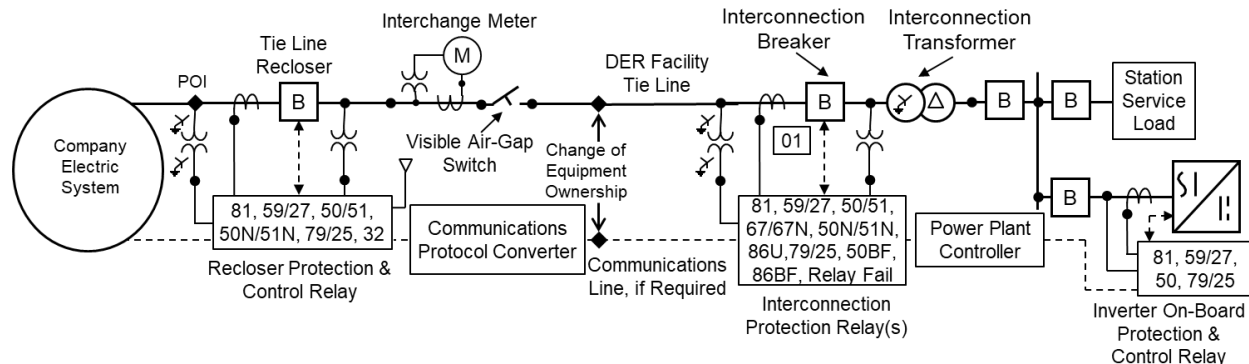
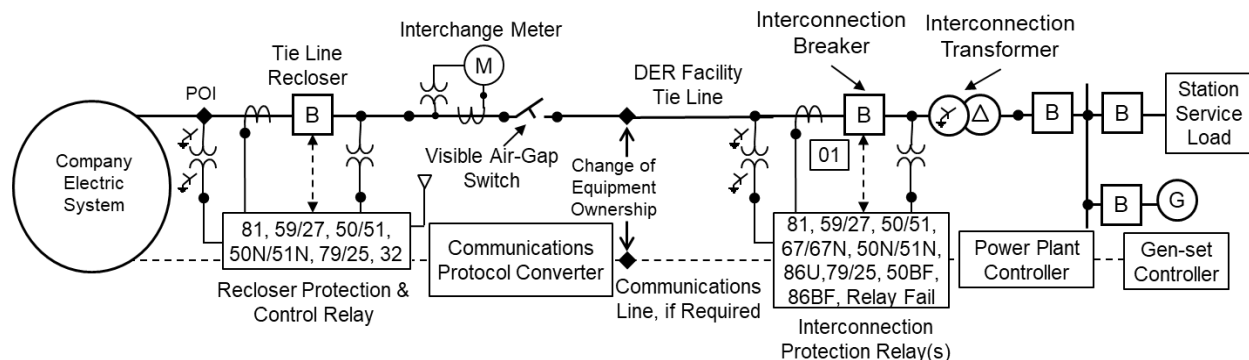


Figure C3 – Non-inverter-based machine DER interconnection with non-Company owned delta/grounded-wye interconnection transformer.





Attachment B – DER Interconnection Pre-Application

The DER Owner or designated representative must complete this form and send complete Application package to the designated Company employee or office along with a map showing the DER and POI locations.

DER Owner Information

DER Owner Legal Name	Account Number	Federal Tax ID Number		
Address	City	State	Zip	County

Physical Location of DER

Address or GPS Coordinates (Lat/Lon)	City	State	Zip	County
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Nearest Meter Number, Pole Number, or Other Information Identifying the POI, if available

DER Generator Type, Size & Energy Source – Generator types include inverter, synchronous generator and induction generator. Energy sources include Battery, Solar PV, Wind, Biomass, Natural Gas, Landfill Gas, etc.

Generator Type	Total Installed Capacity (KW AC)	Energy Source	KW DC Installed if Energy Source is Solar PV
Generator Type	Total Installed Capacity (KW AC)	Energy Source	KW DC Installed if Energy Source is Solar PV

DER Load Information – Largest load is the equipment in the Facility that consumes the most energy (e.g. induction motor, HVAC, battery, etc.).

- a) Facility Total Peak Demand _____ KW AC _____ Power Factor
b) Largest Load Peak Demand _____ KW AC _____ Power Factor

Purpose of DER – This tells Company what the DER Owner plans to do with the DER generated energy.

- ☐ DER Owner intends to use generated electricity to serve DER Loads (**One-way Power Flow**).
☐ DER Owner intends to sell all or a portion of generated electricity to the Company (**Two-way Power Flow**).

DER estimated peak power export to the proposed point of interconnection is _____ KW AC.

I certify that all information provided above is true and correct to the best of my knowledge.

Customer Contact (Print Name)	Title	Signature	Date
Email Address			
Phone Number			

ATTACHMENT C TECHNICAL DATA FORM



SYNCHRONOUS GENERATOR

Copy this form as needed for different equipment type or model numbers.

Quantity	
Nameplate Data	
▪ Manufacturer	
▪ Model Number	
▪ Number of Phases (3 or 1)	
▪ Winding Connection If 3 Phase (Wye or Delta)	
▪ Rated Frequency (Hz)	
▪ Rated Speed (RPM)	
▪ Rated Voltage (kV)	
▪ Rated Apparent Power (kVA)	
▪ Rated Power Factor (%)	
▪ Rated Excitation Voltage (V)	
Reactive Capability	
▪ Maximum Leading Power Factor Capability (%)	
▪ Maximum Lagging Power Factor Capability (%)	
Impedance (% On Rated Voltage and kVA Base)	
▪ Saturated Sub-transient Reactance (X''_{dv})	
▪ Saturated Transient Reactance (X'_{dv})	
▪ Synchronous Reactance (X_d)	
▪ Saturated Negative Sequence Reactance (X''_{2v})	
▪ Positive Sequence Resistance (R_1)	
▪ Negative Sequence Resistance (R_2)	
▪ Zero Sequence Resistance (R_0)	
Time Constants & Inertia (for Stability Study)	
▪ Short Circuit Sub-transient (T''_d) Time Constant (s)	
▪ Short Circuit Transient (T'_d) Time Constant (s)	
▪ Armature Short Circuit (DC) Time Constant (s)	
▪ Generator & Turbine Inertia (WR^2 in Lb-ft ²)	
▪ Inertia Constant (H_c) on Rated kVA (MW-Sec/MVA)	

ATTACHMENT C TECHNICAL DATA FORM



INDUCTION GENERATOR

Copy this form as needed for different equipment type or model numbers.

Quantity	
Nameplate Data	
▪ Manufacturer	
▪ Model Number	
▪ Type of Rotor (Wound/Slip Ring or Squirrel Cage)	
▪ Number of Phases (3 or 1)	
▪ 3-Phase Stator Winding Connection (Wye or Delta)	
▪ Rated Frequency (Hz)	
▪ Rated Speed (RPM)	
▪ Rated Voltage (kV)	
▪ Rated Power (kW)	
▪ Rated Load Current (A)	
▪ If Wound/Slip Ring, Rated Secondary Current (A)	
▪ If Wound/Slip Ring, Rated Secondary Voltage (V)	
Reactive Power Requirements (kVAr)	
▪ No Load Reactive Power Required	
▪ Full Load Reactive Power Required	
Impedance (% On Rated Voltage and kVA Base)	
▪ Stator Resistance (R_s)	
▪ Stator Reactance (X_s)	
▪ Rotor Resistance (R_r)	
▪ Rotor Reactance (X_r)	
▪ Magnetizing Reactance (X_m)	
▪ Short Circuit Reactance (X_d'')	
▪ Zero Sequence Resistance (R_0)	
Inertia	
▪ Generator & Turbine Inertia (WR^2 in Lb-ft ²)	
▪ Inertia Constant (H_c) on Rated kVA (MW-Sec/MVA)	

ATTACHMENT C TECHNICAL DATA FORM

INVERTER

Copy this form as needed for different equipment type or model numbers. Provide a certified type test report for each model numbers that shows applicable **IEEE 1547 design & UL-1741 safety standards**.

Quantity	
Nameplate Data	
▪ Manufacturer	
▪ Model Number	
▪ Type (Grid-Tie/Utility-Interactive or Grid-Forming)	
▪ Application (Solar PV, Storage, DC-Coupled Solar PV + Storage, Electric Vehicle, etc)	
▪ Number of Phases (3 or 1)	
▪ Nominal AC Output Power Frequency Rating (Hz)	
▪ Nominal AC Output Voltage Rating (V)	
▪ Nominal AC Output Real Power Rating (kW)	
▪ Nominal AC Output Apparent Power Rating (kVA)	
▪ AC Output Current Total Harmonic Distortion (%)	
▪ Nominal DC Input Power Rating (kW)	
▪ Nominal DC Input Voltage Rating (V)	
▪ Maximum Leading Power Factor Capability (%)	
▪ Maximum Lagging Power Factor Capability (%)	
Fault Current & Active Island Detection Capability	
▪ Max Output Fault Current (A)	
▪ Max Output Fault Current Time (s)	
▪ Active Island Detection Method (SFS, SVS, Z, etc)	
Power Consumption Data	
▪ Night time Power Consumed (W)	
▪ Daytime Power Consumed (W)	
Communications	
▪ Protocols	
Applicable Design & Safety Standards	
▪ IEEE 1547 Standard (1547-2003, -2014a, or -2018)	
▪ UL 1741 Standard (UL 1741-2010, UL 1741 SA, etc)	

ATTACHMENT C
TECHNICAL DATA FORM



2-Winding TRANSFORMER

Copy this form as needed for different equipment type or model numbers. Provide a certified test report for each model numbers.

Quantity	
Nameplate Data	
▪ Manufacturer	
▪ Number of Phases (3 or 1)	
▪ Rated Frequency (Hz)	
▪ Self-Cooled Rated kVA – Primary/Secondary Windings	
▪ Maximum Rated kVA – Primary/Secondary Windings	
▪ Rated Volts – Primary/Secondary Windings	
▪ Connection – Primary/Secondary Windings	
▪ %Impedance on Self-Cooled Rated kVA & Volts Base	
De-Energized Tap Changer (DETC) Positions	
▪ Position 1 or A	
▪ Position 2 or B	
▪ Position 3 or C	
▪ Position 4 or D	
▪ Position 5 or E	
▪ Position 6 or F	
▪ Position 7 or G	
Modeling Data	
▪ %Impedance X/R Ratio	

ATTACHMENT C TECHNICAL DATA FORM

3-Winding TRANSFORMER

Copy this form as needed for different equipment type or model numbers. Provide a certified test report for each model number.

Quantity	
Nameplate Data	
▪ Manufacturer	
▪ Number of Phases (3 or 1)	
▪ Rated Frequency (Hz)	
▪ Self-Cooled Rated kVA - Primary/Secondary/Tertiary Windings	
▪ Maximum Rated kVA - Primary/Secondary/Tertiary Windings	
▪ Rated Volts – Primary/Secondary/Tertiary Windings	
▪ Connection – Primary/Secondary/Tertiary Windings	
▪ %Impedance on Primary Self-Cooled Rated kVA & Rated Primary and Secondary Volts Base	
▪ %Impedance on Primary Self-Cooled Rated kVA & Rated Primary and Tertiary Volts Base	
▪ %Impedance on Secondary Self-Cooled Rated kVA & Secondary and Tertiary Volts Base	
De-Energized Tap Changer (DETC) Positions	
▪ Position 1 or A	
▪ Position 2 or B	
▪ Position 3 or C	
▪ Position 4 or D	
▪ Position 5 or E	
▪ Position 6 or F	
▪ Position 7 or G	
Modeling Data	
▪ X/R Ratio of %Impedance on Primary Self-Cooled Rated kVA & Rated Primary and Secondary Volts Base	
▪ X/R Ratio of %Impedance on Primary Self-Cooled Rated kVA & Rated Primary and Tertiary Volts Base	
▪ X/R Ratio of %Impedance on Secondary Self-Cooled Rated kVA & Secondary and Tertiary Volts Base	

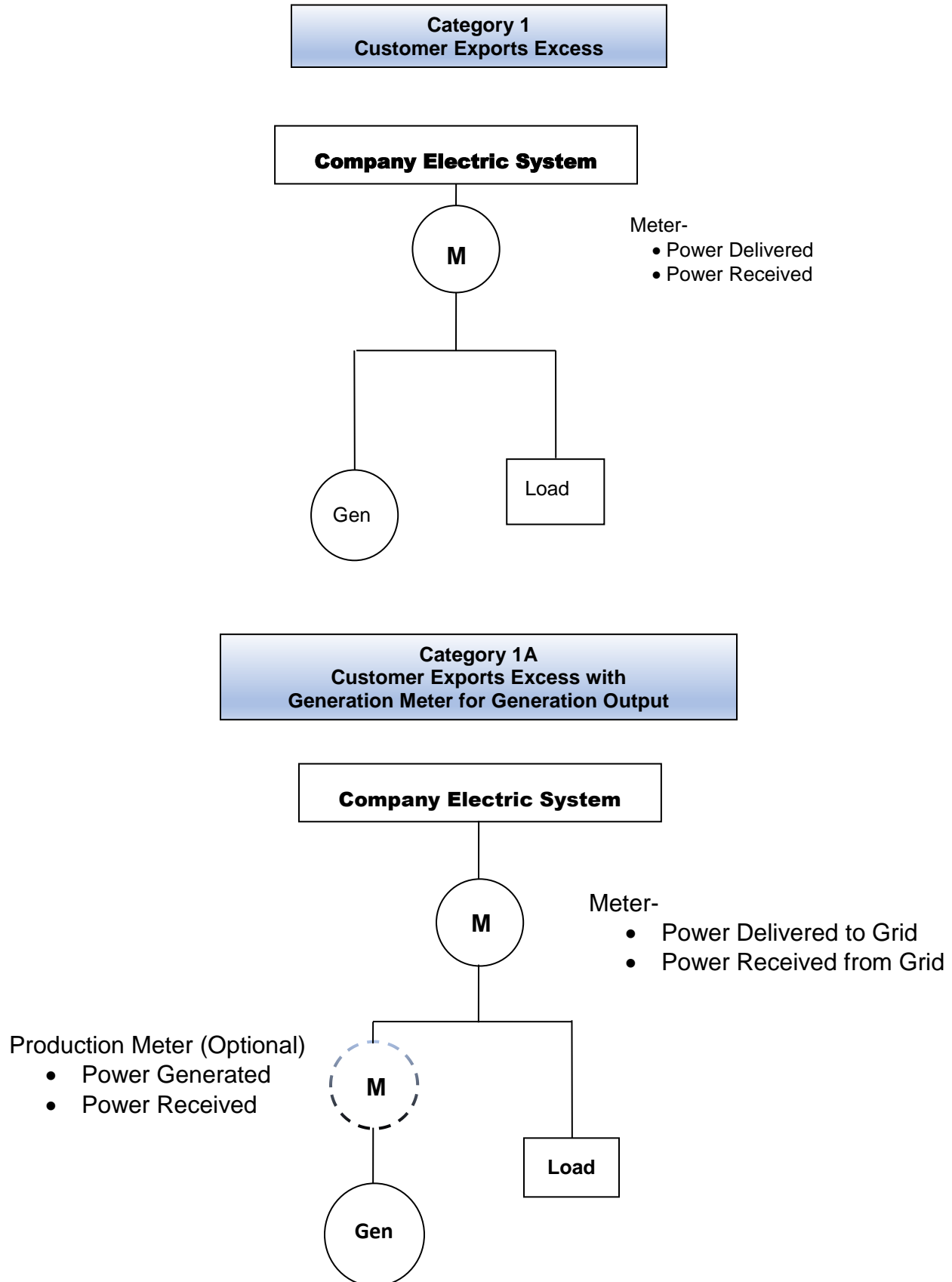
ATTACHMENT C TECHNICAL DATA FORM

POWER CIRCUIT BREAKER

Copy this form as needed for different equipment type or model numbers. Provide a certified test report for each model number.

Quantity	
Nameplate Data	
▪ Manufacturer	
▪ Model Number	
▪ Application (Interconnection, Synchronizing, etc)	
▪ Interrupting Medium	
▪ Dielectric Medium	
▪ Number of Poles / Phases (3, 2 or 1)	
▪ Rated Frequency (Hz)	
▪ Rated Maximum Voltage (kV)	
▪ Rated Impulse Withstand Voltage	
▪ Rated Continuous Current (A)	
▪ Rated Interrupting Current (kA)	
▪ Rated Interrupting Time (cycles)	
Trip & Close Circuit Data	
▪ Trip Circuit Energy Source (Spring, Motor, etc)	
▪ Nominal Trip Circuit Voltage (V)	
▪ Range of Trip Circuit Voltage (V)	
▪ Trip Circuit Energy Source (Spring, Motor, etc)	
▪ Close Circuit Voltage (V)	
▪ Range of Close Circuit Voltage (V)	
Current Transformer Data	
▪ Accuracy Class	
▪ X1 – X5 Full Ratio	
▪ X1 – X2 Tap Ratio	
▪ X2 – X3 Tap Ratio	
▪ X3 – X4 Tap Ratio	
▪ X4 – X5 Tap Ratio	

Attachment D - Metering Arrangements



Attachment D - Metering Arrangements

