2022

Distributed Generation Interconnection Handbook

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THIS MANUAL SUPERSEDES ALL PRIOR ISSUES AND REVISIONS

PUBLISHED BY SALT RIVER PROJECT

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REVISION LOG

Revisions Previous to 10/20/2023		
Standard Title	**Standard Change**	**Date**
Distributed Energy Resource Interconnection Rated Less than 1 MW	PE Stamp	12/21/2023
Interconnection Administrative Information Generator Interconnection Overview	Screens & Technical Study Definitions	04/30/2024
DER Technical Requirements – DER System Requirements	Meter Socket Adapter	09/09/2024
DER Technical Requirements – Application Technical Package Requirements, Site Plans	One Line Diagram Acceptance for DER Interconnection	10/29/2024
DER Technical Requirements – Technical Information and References	Backup Generation Definition	12/04/2024
DER Technical Requirements – DER System Requirements	DER Configuration Assessment Improvements	01/08/2025
DER Technical Requirements – DER System Requirements	Review Pre-Approved Solar Base in ESS 9-33	01/08/2025
DER Technical Requirements – DER System Requirements	DER System Disconnect Switches	02/11/2025
DER Technical Requirements – Technical Information and References	Sealable Compartments	04/15/2025

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1. Preliminary Information

1.1. Purpose

The SRP Interconnection Handbook outlines the process and requirements used to install or modify distributed energy resources (DERs) designed to operate in parallel with the SRP electric system.

This handbook specifies the SRP technical requirements for the safe and effective interconnection of a DER Generating Facility (GF) to the SRP electric distribution system (connections below 69 kV). This handbook is made available at: srpnet.com.

1.2. Scope

Connections to the SRP transmission system (69 kV and above) are controlled by SRP's Open Access Transmission Tariff (OATT) and are outside the scope of this document. Further information about transmission system connections is available at: oatioasis.com/SRP/index.html

The protection devices specified throughout this handbook are intended to protect SRP's electrical distribution facilities and SRP Customers from damage or disruptions caused by a failure, malfunction, or improper operation of the DER. These devices are also necessary to address the safety of SRP workers and the public. The requirements specified herein do not address any additional relaying, nor other protective and/or safety devices as may be required by industry or government codes and standards, equipment manufacturer requirements, and prudent engineering design and practice to fully protect the Customer's DER. Safety requirements and contractual agreements between SRP and the Customer take precedence over the general provisions of this document.

Customers and SRP personnel shall use this handbook when planning the installation of a DER. This handbook may not be all inclusive. Therefore, SRP must be consulted prior to finalizing project plans, designing the facility or purchasing and installing equipment.

1.3. Overview

Throughout this handbook the term "Customer" shall refer to the owner, its agents, or the operator of DERs being interconnected to SRP's electric system. The term "project" shall be used throughout this handbook to refer to a DER interconnection.

Producers of electrical energy must adhere to standards outlined in this handbook to prevent harm to personnel or damage to equipment. The Customer may be liable for damages incurred due to unauthorized operation or improperly configured equipment.

2. How to Use This Book

2.1. Revisions are indicated by red text or graphics.

2.2. Title blocks are used to hold information about the book, section, and standard and are located at the bottom of the page.

2.2.1. "Approval" refers to the engineer responsible for that standard.

2.3. “Issue Date” is when the standard was originally created.

2.4. Revision Date (“Rev Date”) is the date the standard was last updated. Note that standards are reviewed periodically by the responsible engineer, and if no updates are necessary in that review, the Rev Date will remain unchanged.

2.5. Revision statements are a summary of the changes made on the page and are located at the top of the title block.

2.5.1. If a revision results in the complete removal of a diagram or an entire section of a diagram or a complete section of text, a brief explanation of the removal will be entered in the revision statement location of the title block.

2.6. Revisions to formatting and corrections to typographical errors and/or page numbers will not be noted as a revision date change, however, it will be entered as a change in the Standards Revision Log.

2.7. Utilizing SRP Standards

2.7.1. When utilizing SRP’s standards in design projects, modification of said standards is NOT permitted.

2.7.2. Details or images may be extracted and used in design projects when they do not include the title block of the standard and are not presented as a standard.

2.8. Watermarks

2.8.1. Standards

a) For Reference Only – Standards that are not for new construction. Existing facilities may be maintained or replaced as like for like. Replaces Reference Only, Obsolete for Reference Only, Obsolete for Replacement Only, Obsolete Reference Only, Reference Only Do Not Construct, and Remove or Replace Only. For Removal Only – Standards that are not for new construction. Existing facilities not maintained or replaced. Replaces Obsolete for Removal Only and Reference Only Remove When Located.

3. Changes to Standards

These standards are subject to update and modification at any time. Printed copies of this manual are provided as a courtesy, but may not include the most up-to-date standards, references, or requirements. To access current standards, visit:

https://srpnet.com/menu/electricbiz/specs.aspx

4. Contact Information

4.1. Business and Residential

Blue Stake	Within Maricopa County Outside of Maricopa County	**(602) 263-1100** **(800) 782-5348**
Business Center	General Information Complimentary energy consultation	**(602) 236-8833**
Distributed Energy Programs Commercial	SRPSolarBiz@srpnet.com srpnet.com/environment/solar/business/contractorinfo.aspx Guidance for Commercial Customers: srpnet.com/environment/solar/business/choosingsolar.aspx	**(602) 236-4663**
Residential	DER@srpnet.com srpnet.com/menu/electricres/solar.aspx	**(602) 236-4661**
Electrical Emergencies	**NOTE:** Call 9-1-1 first for medical emergencies. Fallen Power Lines, Arcing, Electric Shock, Damage to SRP Facilities	**(602) 236-8811**
Residential	General Information, Billing Inquiries, Power Outages, Maintenance of SRP Facilities, Temporary Disconnect, Inspections	**(602) 236-8888**
Spanish	La Linea – servicio en español	**(602) 236-1111**
SRP Water (Irrigation)	Emergencies, Water (Irrigation), Flooding, General Information, Billing Inquiries, Irrigation Orders, Schedule Time Inquiries	**(602) 236-3333**
Location of Underground Facilities	National “Call Before You Dig” (“One Call” Office)	**811**

4.2. Additional Resources

Graphic Records:	Contract construction companies can request printing services online at srpnet.com/electric/business/graphicrequest.aspx
Shop Drawings:	Customers are required to supply shop drawings for service entrance sections with non-pre-approved meter pedestals (single or double), non-pre-approved 320 amps, and all 400 amps and above. Email shopdraw@srpnet.com. Customers are required to supply shop drawings for DER metering equipment and related disconnects that are CT rated at 400 amps and above. Email DERshopdraw@srpnet.com. PDF files are preferred for all shop drawings.
Standards-related questions or for historical copies or versions of Standards email: Engineering_Standards@srpnet.com	
SRP's website:	srpnet.com Residential / Business Electric / Water assistance information.

5. Area Business Office Locations

East Valley Service Center……...7050 E. University Dr., Mesa 85207
Project Administration Building……..…….....1500 N. Mill Ave., Tempe 85281
Pinal County Customer Service Center……....3735 E. Combs Rd., Queen Creek 85242
West Valley Service Center……..221 N. 79th Ave., Tolleson 85353

6. SRP Service Area

The SRP service area map can be viewed at srpnet.com/about/servicearea.aspx.

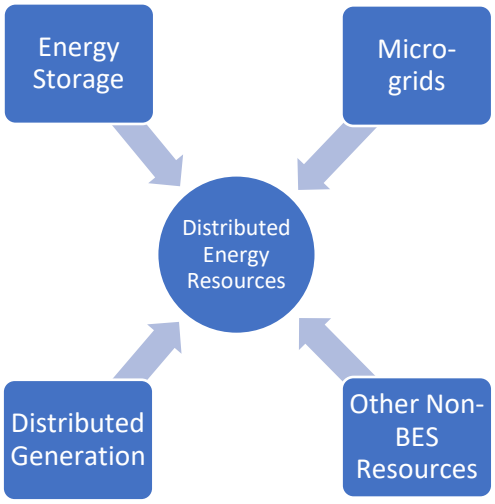
7. Frequently Asked Questions (FAQs)

Use the link below to review a list of FAQs: srpnet.com/environment/solar/business/faq.aspx

1. Generator Interconnection Overview

1.1. What is an Interconnection?

An interconnection refers to the physical connection between a Customer's DER and the utility system. Generation is the act of producing electrical energy. A generator produces electrical energy from a resource that can be operated chemically, thermally, mechanically, etc.



DERs which interact, even momentarily with the electric grid, must be continuously maintained and safely operated. Execution of an Interconnection Agreement (IA) by the utility, the Customer, and if applicable, the property owner, helps ensure this. The IA is a legally binding agreement which defines the roles of all parties involved. Core key Customer expectations are summarized in the Customer Rights and Responsibilities.

Sample Interconnection Agreements for inverter-based projects can be found here:

- Less than 1 MW: https://www.srpnet.com/assets/srpnet/pdf/doing-business/builders-developers-contractors/distribution-interconnection-agreement-sample.pdf
- 1 MW and Larger: https://www.srpnet.com/assets/srpnet/pdf/energy-savings-rebates/business/solar-distribution-interconnection-agreement-1MW.pdf

At SRP, Interconnection Agreements are required for the Customer to interconnect to the utility system. Information for Customers and the steps to take to safely interconnect your DER system to SRP's electric grid can be found here:

- Guidance for Residential Interconnections: https://www.srpnet.com/doing-business/builders-developers-contractors/info-residential-solar-contractors
- Guidance for Commercial Interconnections: https://www.srpnet.com/doing-business/builders-developers-contractors/info-commercial-solar-contractors

SRP assesses each interconnection project for potential hazards or negative grid impacts. The depth of evaluation is based on technology, size, and unique point of interconnection. Utility procedures including protection, grounding, metering, and communications may vary as project size increases or as distributed generation increases on a specific phase or distribution circuit.

1.2. What is Parallel Operation?

Parallel operation involves a Customer DER running while connected to the electric grid, producing energy in conjunction with the utility supplying energy. During parallel operations, the Customer DER becomes a part of SRP's electric system and must be considered in planning the protection of this system.

The electric grid is carefully monitored and managed by SRP. Any power demand must be met by sophisticated coordination of generation assets. Care must be taken to ensure voltage, frequency, and phase angle between the two parallel systems are within acceptable limits.

Customer DER will be analyzed at the point where it impacts the electric grid, this point in a system is referred to as the Point of Interconnection (POI). This point is accessible by both the utility and the Customer for direct measurement.

1.3. Types of Generation

Distributed Generators include induction and synchronous electrical Generators as well as any type of static inverter capable of producing AC power. See Section 2 - 1.9: Protective Design Considerations in this Handbook for more information regarding static inverters and synchronous and induction generation units.

1.3.1. Inverter-Based (Static)

A static inverter is a power electronic device that converts direct current (DC) electricity to alternating current (AC) electricity. Examples of inverter-based resources can include solar photovoltaic and battery energy storage systems (BESS).

1.3.2. Rotating Machines

An induction or synchronous machine (or machines) is used to generate AC electricity. Examples of induction generation can include wind and hydroelectric power systems. Examples of synchronous generation can include thermal and nuclear power systems.

1.4. Energy Storage

Renewable energy sometimes relies on seasonal or hourly time-varying resources. Energy Storage (ES) systems enable facilities to mitigate the energy demand when those resources are temporarily unavailable or sparse.

ES systems can reserve excess electrical energy not immediately used. This can be in the form of mechanical pumping, compression, flywheel, or other technologies, such as electrochemical, electrical, or thermal. ES systems capable of supplying energy to the electric grid qualify as DERs and must adhere to the same safety standards as other interconnected generation. Like rotating machines or inverter-based generators, the method of energy storage will often require power conversion and grid-synchronization equipment to operate in parallel with the grid.

1.5. Microgrid Defining Characteristics:
Requirements for the Microgrid shall be evaluated on a case by case basis. Below are the defining characteristics for the Microgrid on SRP's system.

a) Microgrids are capable of operating in parallel or islanded from the area electric power system (Area EPS) and not solely an emergency back-up generator.

b) Has a group of distributed energy resources (more than one DER).

c) Clearly defined electrical boundaries.

d) Incorporates an Island Interconnection Device at a Point of Common Coupling (PCC).

e) Incorporates a control system (Master Microgrid Controller) to manage and dispatch resources as a single controllable entity.

1.6. Using Generation During an Outage

Distributed generation systems can be designed to operate during an outage. This is synonymous with electrical system islanding or formation of a microgrid. Since these energized systems present potential hazards to personnel who may be working on the electric grid to restore outages, their design needs to be carefully reviewed and tested to ensure safe and reliable operation.

1.7. Customer Rights and Responsibilities

1.7.1. SRP Rules and Regulations

a) Refer to the SRP Rules and Regulations at srpnet.com/about/pdfx/rulesandregs.pdf for the complete detailed rights and responsibilities. Section 6 details liability and responsibility for Customer equipment and its operation.

b) The Customer is responsible for obtaining and maintaining required permits and inspections to indicate that the Customer's DERs comply with all applicable codes, ordinances, and statutes relating to safety, construction, and operation. These include easements to clear trees when applicable and rights-of-way for installation and maintenance of any SRP interconnection facilities.

1.7.2. The Customer shall own and be responsible for designing, installing, operating, and maintaining:

a) The DER in accordance with the requirements of applicable electric codes, laws, and governmental agencies having jurisdiction.

b) Any control and protective devices, in addition to protective relays and devices specified in this Handbook, to protect its facilities from abnormal operating conditions such as, but not limited to, electric overloading, abnormal voltages, and fault current. Operation and maintenance of control and protective devices includes performing operational testing to demonstrate system functionality to SRP, and performing continued protective relay, Smart Inverter, and disconnect equipment testing according to manufacturer specifications.

c) Additional interconnection facilities, not owned by SRP, on the Customer's premises may be required to deliver power from the Customer's DER to the SRP system at the POI.

d) It is the Customer's responsibility to submit the specifications and detailed plans as required in this Handbook to SRP for review and written approval prior to purchase and installation. Written approval by SRP does not indicate acceptance by other authorities.

1.8. Choosing a Contractor

Typically, a Customer will need to contract with a licensed contractor in order to have a system designed and built. There are many options and SRP recommends obtaining multiple quotes before selecting a contractor. These quotes should be provided at no cost to the Customer.

1.9. Process

If a proposed DER is intended to produce energy for local use, an evaluation of historical premises energy bills helps provide a starting point for system type and size requirements. Evaluation of the time of energy use is also valuable for intermittent energy sources such as solar. When financing a project, consider that the total cost of ownership should include provisions for DER maintenance and upkeep.

1.10. Costs

The Customer is responsible for all costs required to interconnect the Customer's DER to the SRP system. This includes connection, transformers, protective relaying, metering, utility disconnect switch, and any other requirements outlined in this Handbook, the Electric Service Specifications, SRP Rules and Regulations, and any applicable special items specified by SRP. If additional facilities or equipment are required to be installed on the SRP system resulting from the Technical Reviews to accommodate the Customer's DER, SRP shall install such facilities or equipment at the Customer's expense. SRP may also charge the Customer for administrative costs and/or the costs of technical studies required to interconnect the Customer DER.

2. DER Interconnection Application Process

SRP's Interconnection process was developed to provide a transparent and efficient means for a Customer to interconnect their Generating Facility to SRP's electric power system, while maintaining safety, reliability, and power quality specifications.

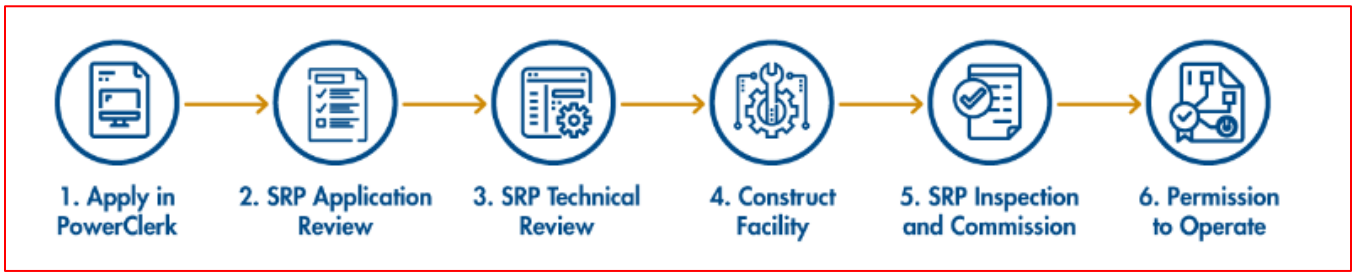
All projects are to be reviewed and approved by SRP. This process is facilitated through an online application system (PowerClerk) and provides all parties a central location to monitor project status. The application details are often submitted by developers or contractors on behalf of the Customer.

If changes to any portion of the application package are made after the application is accepted, the customer and/or their contractor must submit a Customer Change Request for Submitted Applications form available within the PowerClerk application, along with copies of all applicable documents that must be revised as a result of the changes. Please note that the application may move back in the process depending on the changes, resulting in a lengthier application processing time.

Refer to the tables at https://www.srpnet.com/energy-savings-rebates/business/installing-solar-panels for SRP's "Interconnection costs and timeline for inverter-based projects" and "Interconnection costs and timeline for non-inverter-based projects."

NOTE: SRP recommends the Customer is granted access to their project web portal in order to monitor status and activity.

Fig. 1: Interconnection Application Process Flow Diagram



2.1. PowerClerk Application

Within the PowerClerk web application, the Interconnection Application form is the primary means of supplying project data to SRP. This data is used to evaluate the safety and reliability of a grid interconnection. To initiate a project, an applicant shall register an account, then complete and submit a new Interconnection Application form, including all the requested information and documentation.

2.2. Submitted Applications

Following submission of the application, it is reviewed for completeness and advanced to the net step in SRP's interconnection application process. Additional information may be requested of the applicant, which may require coordination between applicant, developers, Customers, engineers, and system owners – all parties external to the utility. This may include but not limited to the Customer providing SRP any manufacturer's brochures, instruction manuals, technical specifications, certifications, and test reports for evaluation.

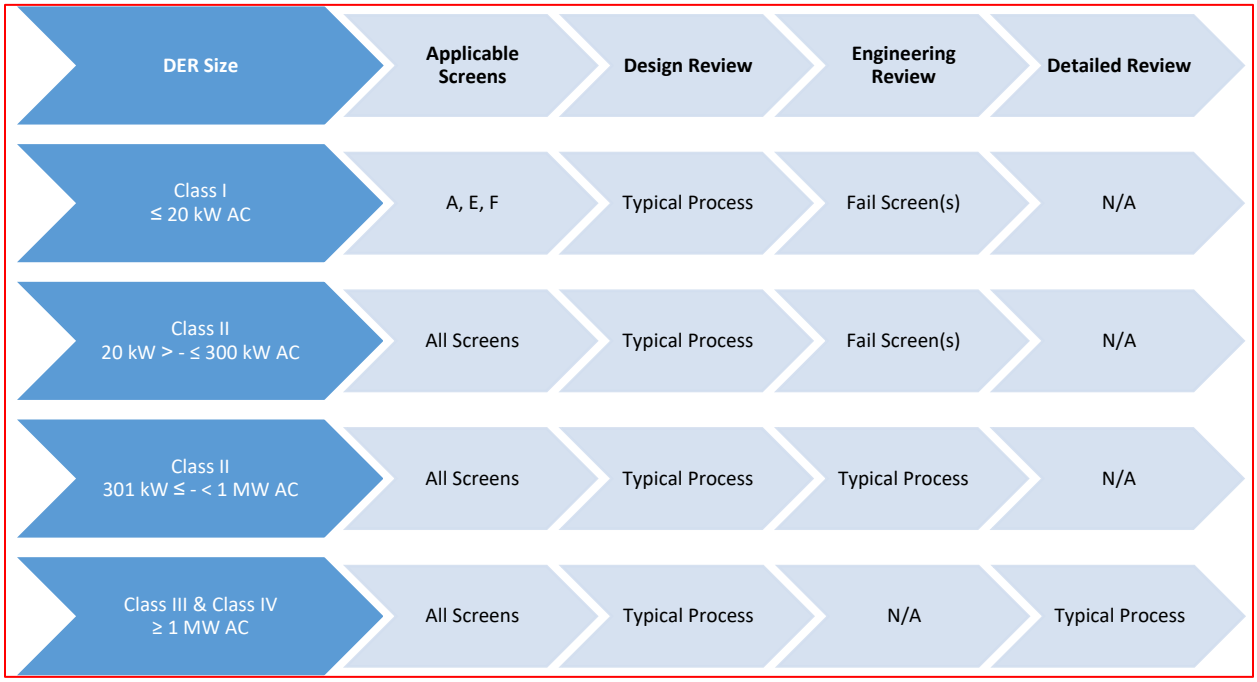
2.3. SRP Technical Review

2.3.1. As a part of SRP's Technical Review, all applications are subject to SRP's Interconnection Application Screens in addition to a Design Review, Engineering Review, and/or Detailed Review, depending on the size of the DER system. These Screens are an opportunity for SRP to improve upon the existing Interconnection Application Process, maintain grid safety and reliability, and proactively prevent grid issues from increased DER penetration. SRP has implemented the following Screens:

Fig. 2: Technical Screen Evaluations and Definitions

Screen	Description
A (Hosting Capacity)	Is the aggregated generation, including the proposed Generating Facility, on the circuit less than the minimum hosting capacity of the most limited section on the circuit? (Y/N)
B (Fault Current)	Is the proposed Generating Facility Fault Current contribution less than 10% of the distribution circuit's maximum fault current value at any point on the Distribution System? (Y/N)
C (Short Circuit)	Is the aggregate Maximum Capacity of existing generation facilities, including the proposed Generating Facility's Maximum Capacity, connected to the proposed distribution circuit less than 90% of any distribution protective devices and equipment short circuit interrupting capability? (Y/N)
E (Service Transformer Rating)	Does the aggregate generation, including the proposed Generating Facility, exceed SRP determined transformer overload rating? (Y/N)
F (Inverter Voltage)	Will the proposed Generating Facility, connected to a 1-phase system connected to a transformer providing a 120/240V secondary service, current imbalance be <= 20% of the nameplate rating of the service transformer between the two sides of the 240 Volt service? (Y/N)
G (Transient Stability)	Is the proposed Generating Facility, in aggregate with other generation interconnected to the distribution side of the substation transformer feeding the distribution circuit, less than 10 MW in an area where there are known or posted transient stability limitations to generating units located in the general electrical vicinity? (Y/N)
J (Non-inverter based)	Is the Generating Facility a spinning mass/synchronous generator? (Y/N) If yes, the Generating Facility must comply with the Protective Function requirements and any additional Utility Interconnection requirements specified by the Utility in its Interconnection Manual.

Fig. 3: Technical Review Process for Interconnection Applications that Pass or Fail the Technical Screens



2.3.2. Design Review

SRP shall assign a design consultant to review the drawings to ensure the proposed installation will comply with SRP interconnection requirements. All applications go through a Design Review and depending on the DER system size and configuration, a pre-construction site visit may be required.

2.3.3. Engineering Review

2.3.3.1. All Class II (301 kW ≤ to < 1 MW) project applications will go through the typical Engineering Review process, whether they pass or fail the Screens. Applications that fail a Screen(s) helps SRP identify what solution(s) are required to help mitigate the Screen failure(s). The Engineering Review is more indepth then the Design Review and these projects may require protection and control equipment used to protect SRP's electric system.

2.3.3.2. All other projects that fail the applicable Screen(s), will go through an Engineering Review. This helps SRP identify solution(s) required to help mitigate the Screen failure(s).

2.3.4. Detailed Review

All Class III and Class IV projects are subject to advanced technical screening to determine their impact on SRP's electric system, whether they pass or fail the Screens. This can include a Feasibility Study, System Impact Study, and Facility Study. Applications that fail a Screen(s) helps SRP identify what solution(s) are required to help mitigate the Screen failure(s). As a part of the Detailed Review, other equipment such as supervisory control and alarms, telemetering, and associated communications may also be necessary.

2.3.5. Interconnection Application Revisions

For any application that fails a Screen(s) or does not meet the requirements from any SRP Technical Review, SRP shall notify the Customer with a clear statement as to why they were not approved. Where appropriate, SRP shall indicate the required changes or modifications needed on the engineering design drawings and/or identify system improvements or upgrades that must be made prior to moving forward in SRP's interconnection application process. All correspondence will be made through the PowerClerk application.

SRP pledges to make every effort to clearly convey requirements and to facilitate successful Customer-sided interconnection. For any questions or help with your distribution interconnection application, please email SRPSolarBiz@srpnet.com or call 602-236-4663.

3. Interconnection Process – Permission to Operate

3.1. Construction

3.1.1. A Customer's DER Facility shall be installed in accordance with the requirements of the local AHJ, NEC, and SRP. The DER Facility must comply will all applicable construction laws, codes, and safety standards. The Customer is also responsible for obtaining applicable building permits from the authority having jurisdiction (AHJ), along with appropriate inspection clearances for their GF.

3.2. Inspection and Commissioning

3.2.1. SRP may require the as-built design drawings for approval and may schedule a site visit for final inspection. The design drawings shall be submitted by the Customer in accordance with the Application Technical Package Requirements. SRP shall either approve the design drawings per field conditions or return them to the Customer with a clear statement as to why they didn't pass inspection. Where appropriate, SRP shall indicate required changes on the engineering drawings and corrections that must be made to the facility prior to commissioning. All correspondence will be made through the PowerClerk application.

3.2.2. Final Inspection

Following approval of the as-built design and authority having jurisdiction (AHJ) certification, SRP qualified inspectors shall perform a final on-site inspection validating that the following are in compliance with SRP requirements:

a) DER equipment location and clearances

b) Disconnect switch and meter socket

c) Wiring and bonding

d) Labeling

NOTE: SRP reserves the right to halt an inspection at any time if a safety violation is suspected. Violations and non-compliance will not be approved for energization and shall be communicated to the Customer, so that re-inspection can be coordinated.

3.2.3. Once a DER Facility has cleared inspection and SRP has received the electrical clearance (or Certificate-in-Lieu of Clearance) and Customer's signed Interconnection Agreement, SRP will schedule commissioning of the GF. Depending on the DER Class, SRP shall perform additional testing to verify consistent communication back-haul, telemetry points, remote control and disconnect, as applicable.

3.2.4. For DER sites 1 MW or larger, the Customer shall have all associated protective devices field-tested and calibrated by qualified personnel. Calibration shall include on-site testing of trip set points and timing characteristics of the protective functions. Written copies of the results shall be sent to SRP at least seven calendar days, excluding holidays, prior to the witness testing described below. If there are differences in the original design settings and the field settings, SRP may require additional time to review those differences prior to witness testing.

3.2.5. Witness/Commissioning Test for Class III and Class IV Generation:

On the day of witness testing, the Customer shall demonstrate, in the presence of SRP personnel that:

a) Relay settings are consistent with the written calibration tests previously provided by the Customer.

b) Operation of each protective output contact results in the desired operation of the appropriate protective device (usually a breaker or contactor).

c) The DER is capable of synchronizing with SRP's grid.

d) The DER properly disconnects from the SRP electric system under simulated disturbance conditions.

e) SRP remote visibility or control of any devices associated with the DER function properly.

f) Settings of programmable logic devices are correct.

g) If a DER does not pass the witness testing, the failing criteria is noted and communicated to the Customer. Re-testing can be scheduled when any issues are corrected.

NOTE: SRP reserves the right to halt an inspection or commissioning at any time if a safety violation is suspected. Violations and non-compliance will not be approved for energization and shall be communicated to the Customer, so that re-inspection can be coordinated.

3.3. Permission to Operate

3.3.1. Upon successful completion of inspection and commissioning, the Customer's distributed energy system will be ready to be energized and SRP will install the billing meter. A "Permission to Operate" and executed Interconnection Agreement will be sent to the Customer authorizing parallel operation.

3.3.2. The Interconnection Application is now closed.

SECTION 2: DER TECHNICAL REQUIREMENTS

1. Technical Information and References

1.1. Applicable Standards

There are numerous documents and standards that were used in developing these requirements. Many of these documents are modified and updated over time; the equipment of an interconnected generator shall conform to the most recent versions of these documents. A partial list of documents used is included below:

- IEEE 1547 – "IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces"
- IEEE 1547.4 – "IEEE Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems"
- IEEE 519 – "IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems"
- IEEE 1453 – "IEEE Recommended Practice for the Analysis of Fluctuating Installations on Power Systems"
- IEEE 2030.2 – "IEEE Guide for the Interoperability of Energy Storage Systems Integrated with the Electric Power Infrastructure"
- IEEE 929 – "IEEE Recommended Practice for Utility Interface of Residential and Intermediate Photovoltaic (PV) Systems"
- UL 98 – "Standard for Safety – Enclosed and Dead-Front Switches"
- UL 1008A – "Standard for Transfer Switch Equipment Over 1000 Volts"
- UL 1741 / UL 1741 SA – "Standard for Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources"
- NFPA 70 – "National Electric Code"
- NFPA 850 – "Recommended Practice for Fire Protection for Electrical Generating Plants and High Voltage Direct Current Converter Stations"
- NFPA 855 – "Standard for the Installation of Stationary Energy Storage Systems"
- ANSI C84.1 – "American National Standard for Electric Power Systems and Equipment Voltage Ratings (60 Hz)"
- OSHA part 1910 and 1926 – Subpart K and V
- SRP Electric Service Specifications
- SRP Rules and Regulations

1.1.1. National Electric Code (NEC)

a) Article 705

All wiring methods & equipment shall comply with applicable portions of the NEC (latest edition) and Authority Having Jurisdiction (AHJ). Ambient Temperature Correction Factors shall use a minimum temperature of 110°F and shall be coordinated for terminals, conductors, and devices.

Labeled equipment shall not be modified unless done with a manufacturer's labeled retrofit kit, or the modification is certified by a qualified third party.

A Supply-Side Source Connection Art. 705.11 (A thru E) shall be located at the service entrance section, after the SRP billing meter and before the source side of the service disconnect, outside of any sealed area.

Approved methods for protection of conductors:

Above ground: RMC, IMC, or approved fiberglass

Below ground: PVC

A Load-Side Source Connection Art. 705.12 (A through E) shall be located at the service entrance section, after the SRP billing meter on the load side of the service disconnect, outside of any sealed area.

No devices by the Customer shall be installed in or attached to a sealable area. This includes, but is not limited to, a meter panel cover, meter cabinet, metering compartment, test block or safety socket cover, and the pull section area of a service entrance section. Line and load conductors shall not be located in the same pull section.

1.1.2. OSHA 1926 – Subpart V: Electrical Safety

a) Article 961

De-energizing of transmission and distribution lines and equipment for the purpose of protecting employees.

b) Article 405

Wiring methods, component, and equipment for general use.

c) Article 406

Specific purpose equipment and installations – Disconnects.

1.1.3. Energy Storage System Standards

a) Refer to the following industry fire safety standards prior to the implementation of an energy storage system:

(1) NFPA 855 – Standard for the Installation of Stationary Energy Storage Systems

(2) UL 9540A – Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

b) Refer to the latest version of the following standards to aid in the design, operation, and maintenance of energy storage systems:

1. IEEE 2030.2.1– IEEE Guide for Design, Operation, and Maintenance of Battery Energy Storage Systems, both Stationary and Mobile, and Applications Integrated with Electric Power Systems.

2. PNNL-SA-118870 / SAND2016-5977R – Pacific Northwest National Laboratory in conjunction with Sandia National Laboratories Energy Storage System Guide for Compliance with Safety Codes and Standards.

1.2. SRP Standards for Preparation

1.2.1. SRP Electric Service Specifications (ESS) Book

The ESS was created by SRP to present information and general specifications relative to the introduction and use of electricity supplied from its lines.

The information and specifications included in the ESS relate to conductors and equipment connecting SRP's electricity supply system to customer premises, as well as other subjects associated with the supply of electricity that are of mutual interest to the customer, architect, engineer and electrical contractor. It is not a complete set of rules governing the installation of electrical wiring and equipment.

This book specifies design requirements for overhead service, underground service, residential and commercial types of service, etc. It is available here: srpnet.com/electric/business/specs/ess.aspx for licensed electrical contractors.

a) Meter Sections

Customers must furnish and install, at Customer's expense, meter sockets and metering cabinets compliant with the specifications in the ESS, Section 9: Metering & SES.

The Customer shall ensure that the design and installation of electric meter(s) meet SRP's requirements in the ESS. This includes the assurance that the meter(s) are located on the utility side of the generator breaker on a normally energized bus and that any electronic meter(s) are not de-energized for any length of time. Contact SRP for design requirements and installation details.

Refer to ESS Section 9: Metering & SES for a list of pre-approved meter sections. Equipment that is not approved can be evaluated for interconnection on a case-by-case basis.

1.2.2. Clearances

Clearances are detailed in ESS Section 5: Clearances.

a) Required Footprint for Workers

Refer to ESS Section 5: Clearances, Service Entrance Section Locations, Heights & Working Space Clearance.

b) Equipment Clearance

The utility AC disconnect switch, dedicated DER meter and associated DER system disconnect switch shall be grouped together within a maximum distance of 10' of the SES for residential DER facilities or within 30' of the SES for commercial DER facilities, with no obstructions (sharing a common corner of the structure is allowed), and is readily assessable as required in ESS Section 5: Clearances and ESS Section 9: Metering & SES.

EXCEPTION: If conditions prohibit grouping the SES, utility AC disconnect switch, dedicated DER meter, and associated DER system disconnect switch together per the maximum distances described above, these facilities may be remotely located with SRP and AHJ approval. The remote

location must be readily accessible as required in ESS Section 5: Clearances and ESS Section 9: Metering & SES. The SES shall have signage, including a site map, indicating the interconnected generator(s), along with the specific location of the dedicated DER meter(s) and associated disconnect switch(es), as applicable.

1.2.3. 24-hour Access

At all times, SRP personnel shall have 24 hours a day, 7 days a week access to the disconnect switch(es) and service meter of DER for any purpose in connection with the performance of the obligations imposed by the interconnection agreement (IA), to meet SRP's obligation to operate the area EPS safely, and to provide reliable quality services to SRP Customers. As necessary for SRP to operate, maintain, inspect, test, repair or replace its facilities, the Customer shall allow SRP access to the equipment and facilities located on the premises.

If a DER facility is protected by an electric gate, SRP shall require installation of an approved restricted access switch (RAS) where vehicle access is barred. SRP RAS is specified in ESS Section 1: General Information, Restricted Access Switch (RAS).

1.3. Signage and Labeling

The Customer shall conform to the NEC and ESS for labeling of DER equipment, switches, breakers, etc. For labeling requirements refer to Section 2 – 6.6: DER Signage within this Handbook.

1.4. Design Requirements

This section applies to all DER operating (or applying to operate) within SRP's electric system. This establishes technical requirements that promote the safe and effective parallel operation of Customer DER and includes provisions for interconnecting three distinct types of generators: (a) static inverter, (b) induction machine, and (c) synchronous machine.

1.4.1. A fault current is any abnormal electric current. Fault current can be created by a short circuit when current bypasses the normal load, or by an open circuit when the current is interrupted by a failure such as a break in the line or a failed-open device. In either of these scenarios, it is important to design electrical protection to disconnect or isolate the fault so repairs can safely occur.

1.4.2. The electrical distribution system is designed with protective devices such as fuses, relays, breakers, and reclosers that are set to open and safely isolate sections of a circuit. As such, a DER must be configured to be sensitive to faults and limit its contribution to a fault. When not properly configured, DERs can continue to energize a portion of a feeder that is assumed de-energized. This is extremely hazardous to operations personnel that would be performing work on this section. Equipment must be able to be properly and definitively isolated before any work can occur.

1.4.3. The protection and safety devices and other requirements specified in the following sections are intended to provide protection for the SRP Electric System, SRP workers, other SRP Customers, and the general public. They are not intended to provide protection for the Customer's DER equipment or personnel; this is the sole responsibility of the Customer.

1.4.4. With respect to the above protection objectives, it is necessary to disconnect the parallel generator when trouble occurs in order to:

a) Limit the fault current supplied by the Customer's generator.

b) Limit the possibility of reclosing into an out of synchronization isolated system composed of the Customer's generator and SRP's electric distribution system or a section thereof.

c) Limit the possibility of reclosing into the Customer's generator system that may be out of synchronization or stalled.

d) Limit the possibility of unintentional islanding.

NOTE: The Customer is solely responsible for the protection of their equipment from reclosing by SRP. SRP normally applies instantaneous (0.1 seconds) reclosing to distribution circuits. The Customer must ensure that when the SRP source breaker trips, the DER is disconnected from the SRP circuit. Reclosing out of synchronism with the Customer's generator may cause severe damage to Customer equipment and could pose a serious hazard to Customer or SRP personnel.

1.5. General Protective Requirements

1.5.1. The connection of multiple DER to the same SRP service may be permitted subject to SRP approval; however, a single disconnect switch for the facility shall generally be required (normally located at the service entrance section).

1.5.2. In the event that a DER, or aggregate of DERs, are of sufficient size to carry the minimum load of the SRP distribution feeder, or if a generator size and physical location on a feeder is such that it could support an isolated (islanded) section of the feeder, then a transfer trip scheme may be required at the Customer's expense based on the findings from the Technical Review. A transfer trip scheme includes a communication channel and telemetering. In certain instances, a dedicated SRP feeder may be required at the Customer's expense.

1.5.3. To prevent the opening and subsequent closing of equipment into an un-synchronized generator, the Customer shall ensure that any potential open points such as breakers or fused disconnect switches, located between the generator breaker and SRP service, are appropriately equipped with interlocks. This is accomplished with either keyed or other suitable mechanical interlocks to prevent the open points from being inadvertently closed when the generator breaker is closed, or by using contacts that will instantaneously trip the generator breaker if any such switch or breaker is closed while the generator breaker is closed.

1.6. Parallel System (Interconnected Generation Systems)

1.6.1. A parallel, or interconnected DER, is connected to a bus common with SRP's system, directly resulting in a transfer of power between the two systems. A consequence of such interconnected operation is that the Customer DER becomes an integral part SRP's electric system that must be considered in the electrical protection and operation of the electric system.

1.6.2. Parallel generators encompass any DER that can electrically parallel with SRP's electric system. Additionally, any generator system using a closed transition-type transfer switch, multi-breaker transfer scheme, or an electrical inverter that can be configured or programmed to operate in a utility interactive mode is classified as an interconnected DER.

1.6.3. Parallel systems include Generating Facilities that operate under the following modes:

a) Exporting System: Designed to operate in electrical parallel with SRP's distribution system and may backfeed (i.e. export power to) the Distribution System at any time.

b) Non-exporting System: Designed to operate in electric parallel with SRP's Distribution System and to never export power from the Generating Facility to the Distribution System across the POI.

c) Inadvertent Exporting System: Designed to operate in electric parallel with SRP's Distribution System, that may experience a momentary and unplanned, uncompensated transfer of electrical energy from a Generating Facility to the Distribution System across the POI.

d) Backup Generation: Designed to operate either continuously or momentarily in parallel with SRP's distribution system through a closed transition transfer switch. This is where a Customer's load is automatically transferred between two power sources (the Customer's Generating Facility and SRP's Distribution System) with minimal or no interruption of power to the Customer's load.

1.7. Separate System (Non-parallel, Emergency, or Stand-by Generation System)

1.7.1. A separate system or non-paralleling system is one in which there is no possibility or intent of electrically connecting or operating the Customer's DER in parallel with SRP's electric system. The Customer's equipment must transfer load between the two power systems in an open transition or non-parallel mode. Separate systems shall require SRP verification that the transfer scheme meets the non-parallel requirements. Additional requirements shall be established by SRP's Technical Review.

1.7.2. The Customer shall conform to the requirements set forth in ESS Section 1: Stand-By Generator or Multiple Serivce and Transfer Switch Requirements.

NOTE: For the installation of bi-directional chargers used for non-parallel, vehicle to home applications, Customers must contact DER@srpnet.com for required protection equipment.

1.7.3. Emergency or stand-by DERs used to supply part or all of the Customer's load during SRP power outages, are required by the NEC to have transfer equipment designed and installed to prevent the inadvertent interconnection of normal and emergency sources of supply in any operation of the transfer equipment.

As such, these DERs must be connected to the Customer's wiring through an open transition (break-before-make) transfer switching scheme. The following are approved methods:

a) Installation of a double throw safety switch complying with UL 98 standards.

b) Installation of a transfer switch complying with UL 1008 standards and specifically designed for that purpose.

c) Installation of a commercial grade trapped key interlock system.

1.7.4. The transfer switch shall be of a fail-safe mechanical throw over design, which will under no circumstances allow the DER to electrically interconnect or parallel with SRP's electric system. The transfer switch shall always disconnect the Customer's load from SRP's power system prior to connecting it to the DER. Conversely, the transfer switch shall also disconnect the load from the DER prior to reconnecting it to SRP's electric system. These requirements apply to both actual emergency operations as well as to testing the DER. All transfer switches and transfer schemes must be inspected and approved by the governmental bodies that exercise legal jurisdiction over electrical installations.

1.7.5. Portable generators are not designed for connection to a building's permanent wiring system and are not to be connected to any such wiring unless a permanent and approved transfer switch is used. Failure to use a transfer switch can result in backfeed into SRP's electric system – the generator voltage can backfeed through the SRP transformer and be stepped up to a very high voltage. This can pose a potentially fatal shock hazard to anyone working on the power lines or on SRP equipment.

1.8. Fast Transition System (Interconnected Generation Systems)

SRP does not require the installation of additional separate protection at sites employing fast transition switching with the following conditions:

a) The Customer signs an interconnection agreement with SRP.

b) The switch be listed to UL – 1008 requirements for Automatic Transfer Switches

c) The Customer demonstrates to SRP's System Protection Department that the transfer switch can switch from utility source to generator and back.

d) The Customer demonstrates that the switch will not parallel the Customer's DER with SRP's electric system for more than 100 milliseconds. If the switch gets stuck while transferring to or from the generator, the back-up switch trips to isolate the generator from SRP within 0.8 seconds.

1.9. Protection Design Considerations

SRP reserves the right to provide protection system settings to the Customer during the design phase or following synchronization. Unless otherwise specified, the recommended default settings from the latest version of IEEE 1547 shall be utilized by the Customer. The Customer is responsible for ensuring redundant or backup protection devices are coordinated with the primary protection device The size and characteristics of the parallel generator along with the nature and operational characteristics of SRP's electric distribution system influence protection requirements. Therefore, similar units connected to different lines could have different protection requirements based on varying load conditions, as well as on SRP feeder and transformer characteristics.

The Customer is responsible for designing the DER system to automatically separate from SRP's electric system for any abnormal condition and be able to trip during an unintentional islanding condition.

1.9.1. Static Inverters

Static inverters convert DC power to AC by means of electronic switching. Switching can be controlled by the AC voltage of the SRP supply system (line commutated) or by internal electronic circuitry (forced commutated). Line-commutated inverters are generally not capable of operating independently of the SRP AC supply system and, as such, cannot normally supply fault current or isolated loads. Forced-commutated, or self-commutated, inverters are capable of supplying fault current and load independently of the AC supply system. The kW rating for a system using static inverters is determined from the aggregate AC output name plate rating of the inverters regardless of the DC rating of the input source.

1.9.2. Synchronous Units

A synchronous generator is an alternating-current machine in which the rotational speed of normal operation is constant, and when interconnected, is in synchronism with the frequency and in step with the voltage of the electric utility system. Synchronous generators are generally capable of supplying sustained current for faults on SRP's electric system.

1.9.3. Induction Units

Induction generators are induction motors that are driven above synchronous speed to produce electric power. These units do not have a separate excitation system and, as such, require that their output terminals be energized with AC voltage and supplied with reactive power to develop the magnetic flux. Induction generators are therefore normally not capable of supplying sustained fault current into faults on SRP's electric system. Such units are generally not capable of supplying isolated load when separated from the electric system; however, it is possible for an induction generator to become self-excited if enough capacitance exists at its output terminals. Under conditions of self-excitation, an induction generator will be capable of supplying isolated load, providing the load is within the units' output capability. In most cases when self-excitation occurs, it will be accompanied by a sudden increase in terminal voltage. SRP and its other Customers must be protected from out-of-sync closing and over-voltages that can occur whenever an induction generator becomes self-excited.

2. DER System Requirements

2.1. DER Size Classification

The following classes define specific minimum requirements for DERs. If a Site has multiple DER connections, the DER size classification will be determined by the sum of all generators connected to SRP's electric system.

1. Class I – ≤ 20 kW; 1 & 3 Phase AC
2. Class II – > 20 kW to < 1 MW; 1 & 3 Phase AC
3. Class III – ≥ 1 MW to < 3 MW; 3 Phase AC
4. Class IV – ≥ 3 MW; 3 Phase AC

2.2. Requirements Applicable to All DER Types

2.2.1. Power Quality

a) The Customer shall ensure that the electrical characteristics of Customer load and generating equipment will maintain SRP's normal power quality requirements. Any deviation from sine waveform or unusual short interval fluctuations in power demand or production shall not be such as to result in impairment of service to other Customers.

b) Harmonics and voltage flicker shall not exceed the limits promulgated in IEEE-519.

c) The Customer shall meet power quality requirements from the latest available SRP Rules and Regulations, Section 6: Customer's Equipment and its Operation. Power quality requirements include but are not limited to harmonics, voltage flicker, polyphase circuit balance, and power factor correction.

d) SRP does not currently require technical studies or system modeling to connect DER projects that are below 1 MW.

2.2.2. Voltage Requirements

a) Customer DER must be rated at 60 Hertz, and be either a single-phase or three-phase system connected at a standard utility primary voltage selected by the Customer subject to utility availability at the premises.

b) Operation of a DER shall not adversely affect the voltage regulation of that portion of SRP's system to which it is connected. SRP's electric system voltage shall not rise above or below 5% of the nominal system voltage. Adequate voltage control shall be provided by the Customer to minimize voltage regulation on the electric system caused by changing generator loading conditions.

2.2.3. Advanced Grid Support

a) As DER adoption/penetration increases, managing power quality becomes more important. The power system industry relies on safety certification with UL – 1741/ UL – 1741 SA, and requires equivalent advanced grid support functionality for non-UL – 1741 SA certified systems, to comply with the latest version of IEEE 1547. While some functions may not be enabled at commissioning, when area power quality is negatively impacted, SRP reserves the right to enable or adjust DER operational control modes to achieve acceptable levels. Advanced grid support functions can include reactive support through power factor control, voltage and frequency ride through, automatic voltage regulating, and frequency response.

b) Static inverters shall be tested to UL Standard for Inverters, Converters, and Controllers for Use in Independent Power Systems, UL – 1741 by a Nationally Recognized Testing Laboratory (NRTL) certified by OSHA to perform the test.

2.2.4. Control Voltage and Loss of Power

All protective devices use a source of power to maintain operation. In an event that there is loss of power from SRP, DER shall be capable of disconnecting from SRP's electric system by opening the DER main breaker. If the protective system uses AC power as the control voltage, it shall be designed to disconnect the generation from SRP's system when AC control power is lost. If DC power is used to control the protective system, there shall be proper relaying to disconnect the DER from SRP's system upon loss of power.

2.3. Requirements Applicable to Interconnections over 3 MW

2.3.1. To maintain system reliability during abnormal conditions, such as serving unexpected load from planned or unplanned outages, higher than normal temperatures, and faster than projected load growth, no more than 3 MW of load or generation from one Customer is allowed to connect to a shared distribution system circuit. A shared circuit is the standard circuit option used to connect multiple Customers to the distribution system. Any circuit that is not dedicated to one Customer is a shared circuit. This ensures all Customers can be served by an adjacent circuit if the need arises.

2.3.2. For a Customer connecting more than 3 MW of load or generation at a Site, a second shared circuit may allow the Customer to connect up to 5.7 MW. The Technical Review will determine the availability and capacity of a second shared circuit for this interconnection, or will identify what solution(s) are required to interconnect that Site.

2.3.3. For a Customer connecting between 5.7 and 10 MW of load or generation at a Site, a dedicated circuit will be required. The Technical Review will identify what solution(s) are required to interconnect that Site.

2.3.4. For a Customer connecting 10 MW or more of load or generation at a Site, the Customer may have options for this interconnection involving dedicated substation transformers. The Technical Review will identify what solution(s) are required to interconnect that Site.

2.4. Customer-Owned and SRP-Owned Equipment

2.4.1. The Customer shall be responsible for operating and maintaining the DER and all associated equipment in accordance with the requirements set forth in the Interconnection Application, along with all applicable safety codes, electrical codes, laws, and governmental agencies having jurisdiction.

2.4.2. The Customer shall maintain their equipment following the manufacturers guidelines and/or industry-accepted practices for the technology type utilized. See the Operations and Maintence Requirements section in this Handbook for additional information.

2.4.3. SRP may request witnessing of functional trip tests of Customer-owned equipment on an annual basis. When requested, the Customer shall notify SRP when such tests are to be performed at least five working days prior to such tests, and allow SRP personnel to witness the testing. In addition, SRP may annually request that all protective devices be field tested and calibrated by qualified personnel, and that written copies of the results be provided to SRP.

2.4.4. SRP, including its employees, agents, and representatives, shall have the right to enter the Customer's premises, and the Customer's DER and associated equipment shall be readily accessible. For it to be readily accessible, it must be capable of being reached quickly and conveniently on a 24-hour basis every day of the year without requiring climbing over or removing obstacles, or obtaining special permission, keys, or security clearance. Reasons for SRP accessing the premises may include, but are not limited to:

a) Inspecting the Customer's DER, protective devices, and to read or test instrumentation equipment that SRP installs.

b) Maintain or repair SRP equipment.

c) Disconnect the DER without notice if, in SRP's opinion, a hazardous condition exists and such immediate action is necessary to protect persons, SRP facilities, or other Customers' or third parties' property and facilities from damage or interference caused by the Customer's DER, or improper operation of protective devices.

d) Open the utility disconnect switch without notice if SRP personnel require an operating clearance or hold tag.

2.4.5. The Customer shall conform to SRP's Distributed Generation Interconnection Handbook, SRP's Electric Service Specifications Manual, National Electric Code, OSHA, and NFPA 70 requirements or the latest available revision for labeling of generation equipment, switches, breakers, etc. Examples of acceptable material to be utilized for labeling can be found in ESS Section 11: Contractor-Supplied Material.

2.5. Metering & Service Entrance Section (SES)

2.5.1. The Customer shall conform to the requirements set forth in ESS Section 9: Metering & SES.

a) No devices by the Customer shall be installed in or attached to a sealable area. This includes, but is not limited to, the meter panel cover, meter cabinet, metering compartment, test block or safety socket cover, and the pull section area of a service entrance section.

b) Line and load conductors shall not be located in the same pull section. Pull sections shall not be used as a j-box or raceway.

2.5.2. Refer to Section 2 – 8.1: DER Meter Bases and Section 2 – 8.2: DER Residential SES Panels within this Handbook for a list of pre-approved meter bases and residential SES panels used for DER applications. Any metering equipment not on the pre-approved list may be allowed for the Customer's DER installation following a request to SRP, which is subject to review and approval.

2.5.3. A sign shall be placed on the exterior of the service entrance equipment indicating the type and location of the on-site equipment specified within the labeling requirements outlined in Section 2 – 6.6: DER Signage section within this Handbook.

2.5.4. The Customer shall provide production metering provisions in accordance with SRP Standard Configuration diagrams shown in the Application Technical Package Requirements section in this Handbook.

2.5.5. For commercial DER facilities, SRP shall own, operate, and maintain the generation metering equipment at the Customer's expense. The generation meter will monitor real and reactive interconnection power flows between the DER Facility and the utility electric

system. Where applicable, separate metering of station power shall be required to accurately meter ES or facility load when the generator is offline.

2.5.6. The Customer shall provide authorized SRP employees access to the premises to install, turn on, disconnect, inspect, test, read, repair, or remove the metering equipment. The Customer shall, at its option, have a representative witness this work.

2.5.7. The Customer shall provide a mounting surface for the meters, recorders, connection cabinets, a housing for the instrument transformers, a dedicated conduit for the conductors between the instrument transformer secondary windings and the meter connection cabinets, and a conduit for the communication links, if required. Metering requirements are specified in ESS Section 9: Metering & SES.

2.5.8. The output of multiple DER shall be combined before connecting to the dedicated DER kWh meter such that each billing meter shall have only one dedicated DER meter and associated disconnect switch used to isolate the entire system.

EXCEPTION: If there are limitations to a Customer's DER system such that it cannot be combined into one dedicated DER meter and associated disconnect switch, a separate DER system shall be constructed in parallel, provided it complies with all other standards governing DER interconnections and is reviewed and approved by SRP. Additional labeling shall be required.

2.6. Interconnection System Equipment – Meter Socket Adapter (MSA)

2.6.1. SRP approves the use of a MSA as an additional interconnection option for a residential Customer's distribution energy resource (DER) system under the following conditions:

a) The device does not impede access to the sealed meter socket compartment or pull section of the sealed compartment of the Service Entrance Section (SES); and

b) The MSA has been tested and approved by SRP. Reference SRP's PowerClerk application for the most up-to-date list of approved MSAs.

2.6.2. A MSA can be used as the interconnection equipment for interconnecting power production or whole-home electric isolation and (intentional or unintentional) islanding of a Generating Faciilty.

2.6.3. The MSA shall meet the established MSA guidelines and requirements listed below:

a) Residential self-contained meter with single phase, 3-wire 120/240-volt service panel, not exceeding a 225-amp rating that meets SRP and AHJ requirements.

b) MSAs shall be UL 414 certified.

c) MSAs shall meet the terminal dimensions listed in ANSI C12.7 and C12.10.

d) MSAs shall be fault current rated adequately for the connected equipment.

e) Only one MSA may be installed per meter base.

f) The MSA must be installed and or removed by SRP following all SRP's meter-pull request processes. The operation and maintenance of the MSA is the responsibility of the Customer. All installations of the Customer's Generating Facility shall be in accordance with requirements of the local AHJ, NEC, and SRP.

- For the purposes of troubleshooting, SRP reserves the right to remove a Customer's MSA. The Customer must submit a meter-pull request to have the MSA re-installed.

g) Subject to exceptions approved by SRP, the main breaker and meter socket shall be contained in the same electrical panel ("all-in-one").

h) All Customer-owned electrical equipment, including MSAs, must satisfy the meter Clearances specified in the SRP Electric Service Specifications (ESS) Manual Section 9: Metering & SES.

i) The equipment grounding conductor must be bonded from the disconnect switch and connected to the service grounding system.

j) A liquid-tight flexible metal conduit, type LFMC, shall be used for current-carrying conductor/wires (greater than 50V) between the MSA and the next DER connection point.

k) MSAs used as a point of interconnecting power production must have a dedicated connection point in the pull section to terminate the neutral pigtail that is associated with the MSA. The neutral pigtail shall not be stacked with the system neutral in the pull section and shall not be terminated on the Customer's side of the service (main service panel) where the neutral and ground are bonded together.

- A Customer may fail SRP inspection if they do not have an "all-in-one" SES panel that allows for the neutral pigtail to be terminated in the pull section.
- MSAs intended for interconnecting power production are not approved for use with Customers who have overhead service panels.

l) A Utility AC Disconnect Switch is still required to be installed between the Customer's SES panel and DER system.

m) An MSA is not allowed to be installed on electric panels that:

- have deteriorated parts or current electrical service requirement violations,
- are rated above 225 amps,
- does not meet appropriate fault current values,
- do not meet appropriate equipment Clearances,
- are a stand-alone meter socket attached to a stem wall or installed separate from a residential building or structure at which service is delivered, or
- where the MSA and/or wires cannot be routed and terminated appropriately.

2.6.4. See Section 2-4.6 in this Handbook for information regarding MSA Installation Arrangement Diagrams.

2.7. Customer Load

The Customer load shall meet all requirements of the current version of the SRP Rules and Regulations, Section 6: Customer's Equipment and Its Operation. SRP reserves the right to refuse or disconnect service when the Customer's wiring or equipment is designed or operated as to disturb service to other Customers or constitutes a physical or electrical hazard, as determined by SRP.

2.8. System Disconnect Switches

2.8.1. Utility AC Disconnect Switch

a) The Customer shall install and maintain a manually operated load-break disconnect switch capable of being locked in a visibly open position by a standard SRP padlock with a 3/8" shank. The disconnect switch shall completely open and isolate the

Customer's DER system from SRP's electric system. For multi-phase systems, the utility disconnect switch shall be gang-operated.

b) The utility AC disconnect switch shall be connected between the SES and DER system. A Customer-fused disconnect switch required for residential and commercial DER systems, with a short circuit rating greater than 10 kA, shall be connected between the SES and utility AC disconnect switch. The Customer-fused disconnect may be separate from the utility AC disconnect or integrated as a single device.

c) The disconnect switch blades, jaws, and the air-gap between them shall be clearly visible when the disconnect switch is in the open position and the front cover of the switch box is open. It is not acceptable to have any of the visible components obscured by a switch "dead front" or an arc shield, etc. Only switches specifically designed to provide a true "visible open" are acceptable.

d) The disconnect switch shall be rated for the voltage and current requirements of the generation facility, and must meet all applicable UL, ANSI, and IEEE standards.

e) The disconnect switch shall meet the requirements of the NEC, including a 36" by 36" clear working space in front of the switch. The switch enclosure shall be properly grounded via a ground wire attached to a factory-provided grounding lug or an appropriately UL-listed grounding lug.

f) The disconnect switch shall be placed under the operational jurisdiction of SRP for systems with a line voltage of 600 V or less, and the cover of such switch shall have the ability to be locked closed with a standard SRP 3/8" shank padlock.

g) The disconnect switch shall be installed in a place to provide easy and unrestricted accessibility to SRP personnel on a 24-hour basis. SRP shall have the right to lock open the disconnect switch without notice to the Customer, when interconnected operation of the Customer's DER with SRP's electric system could adversely affect the electric system, endanger life or property, or upon termination of the Interconnection Agreement. If SRP locks open the disconnect switch, the Customer shall not remove or tamper with the lock.

h) The disconnect switch must be a standalone device or share a common enclosure with the Customer's SES. The supplying and supplied conductors shall not enter and exit through the same raceway or conduit at any point.

i) Under no circumstances shall the disconnect switch enclosure be used as a conduit or raceway for any conductors other than those phase neutral and ground conductors associated with the DER.

j) If conditions prohibit grouping the utility AC disconnect switch, dedicated DER meter, and associated DER system disconnect switch within 10' of the SES for residential DER facilities or within 30' of the SES for commercial DER facilities, with no obstructions (sharing a common corner of the structure is allowed), these facilities may be remotely located with SRP and AHJ approval. The remote location must be readily accessible, as required in ESS Section 5: Clearances and ESS Section 9: Metering & SES. The SES shall have signage, including a site map, indicating the interconnected generator(s), along with the specific location of the dedicated DER meter(s) and associated disconnect switch(es), as applicable.

2.8.2. DER System Disconnect Switch for the Dedicated DER Meter

a) CT-Rated Metering Cabinets with Split Bus Design, or any Service above 240 V

b) Visible open disconnects are required before and after the dedicated DER meter to serve as isolation points of the current transformer-rated (CT) compartment, to isolate the Customer's DER system from SRP's electric system. The Utility AC Disconnect must be on the utility side (load side) of the dedicated DER meter, with the DER System Disconnect Switch on the DER side (line side).

c) DER System Disconnect Switches shall be a separate device, that is manually operated (by means of a physical throw) and must remain lockable while the dead front is open or removed.

2.8.2.1. Self-Contained Metering Cabinets above 240 V

a) Visible open disconnects are required before and after the dedicated DER meter to serve as isolation points, to isolate the Customer's DER system from SRP's electric system. The Utility AC Disconnect must be on the utility side (load side) of the dedicated DER meter, with the DER System Disconnect Switch on the DER side (line side).

b) A dedicated DER meter panel with Test Blocks (Safety Socket) shall be considered a visible open for the DER side (line side) of the dedicated DER meter.

c) DER System Disconnect Switches shall be a separate device, that is manually operated (by means of a physical throw) and must remain lockable while the dead front is open or removed.

2.8.2.2. In cases where the DER System Disconnect Switch will be installed on a line at a voltage above 500 V, SRP will work with the Customer to determine the best option for isolation and ensure that the safety requirements are met.

2.9. Transfer Switch

2.9.1. Stand alone transfer switch for emergency or stand-by generation. See Section 2.- 1.7: Separate System in this Handbook.Closed transition (make before break) transfer switch for Fast Transition System. See Section 2 – 1.8: Fast Transition System in this Handbook.

2.9.2. Transfer switch integrated into the Interconnection System Equipment shall comply with UL – 1741 / UL – 1741 SA.

2.10. DER Protection Requirements by Class

The minimum protective relaying requirements for parallel operation of DER are summarized in the following table:

Table 1: Summary of Minimum Protective Relaying Requirements

Class	AC Output	Inverter Based	Induction	Synchronous
I	≤ 20 kW; 1 & 3 Phase	UL – 1741 SA	Undervoltage	Undervoltage, Synchronizing
II	> 20 kW to < 1 MW; 1 & 3 Phase	UL – 1741 SA	Overvoltage, Undervoltage, Overfrequency, Underfrequency	Overvoltage, Undervoltage, Overfrequency, Underfrequency, Synchronizing
III	≥ 1 MW to < 3 MW; 3 Phase	UL – 1741 SA, redundant over/under voltage relay	Overvoltage, Undervoltage, Overfrequency, Underfrequency	Overvoltage, Undervoltage, Overfrequency, Underfrequency, Synchronizing
IV	≥ 3 MW; 3 Phase	Case-by-case basis	Case by case basis	Case by case basis

2.11. Class I (Single or Three Phase: ≤ 20 kW) Requirements

2.11.1. Class I Synchronous and Induction based DER Requirements

a) The minimum protection required for induction and synchronous generators is an under-voltage relay. A synchronizing scheme is also required for synchronous generators. A manual synchronizing scheme shall require a synchronizing check relay.

2.12. Class II (Single or Three Phase: > 20 kW to < 1 MW) Requirements

a) For installations interconnected to SRP through a transformer with connections that will not supply current to a ground fault on SRP's electric system, a special ground fault detection scheme may be necessary. SRP shall advise the Customer of any such requirements after the Technical Review of the Customer's proposed installation.

b) Other equipment such as supervisory control and alarms, telemetering, and associated communications channels may be necessary. This is especially the case when the generator or an aggregate of generators is large relative to the minimum load on a feeder or sectionalized portion of the feeder, or the DER is involved in power transactions across the electric system. SRP shall advise the Customer of any communications requirements after the Technical Review by SRP Engineering and Operations departments of the proposed installation.

c) SRP shall inform the contractor when the application passes the Application and Technical Reviews. All correspondence will be made through the PowerClerk application and will provide further instruction including when the project has been approved to begin construction.

2.12.1. Class II Synchronous and Induction Based DER Requirements

a) The minimum protection required for induction and synchronous generators is overvoltage, undervoltage, overfrequency, and underfrequency

b) A synchronizing scheme is required for synchronous generators.

2.13. Class III (Three Phase: ≥ 1 MW to < 3 MW) Requirements

a) Utility-grade protection devices and equipment shall be required.

b) Protection required for overvoltage, undervoltage, overfrequency, and underfrequency and a synchronizing scheme.

c) For installations interconnected to SRP through a transformer with connections that will not supply current to a ground fault on SRP's electric system, a special ground fault detection scheme may be necessary. SRP shall advise the Customer of any such requirements after the Technical Review of the Customer's proposed installation.

d) Other equipment such as supervisory control and alarms, telemetering, and associated communications channels may be necessary and will be identified through the Technical Review. This is especially the case when the generator or an aggregate of generators is large relative to the minimum load on a feeder or sectionalized portion of the feeder, the DER is involved in power transactions across the SRP Electric System, or the DER is remotely controlled by or dispatched by SRP. SRP shall advise Customer of any such requirements after the Technical Review by SRP Engineering and Operations departments of the proposed installation.

e) DER facilities 1 MW and above require telemetry. See Customer-Owned Inverter Based Interconnections with Telemetry within this Handbook.

f) Class III projects will be subject to SRP conducted technical studies through the Technical Review. These studies can include Feasibility Study, System Impact Study, and Facility Study. SRP shall inform the Customer of the study outcome through the PowerClerk application, which may require modification of the proposed DER facility or electric system upgrades. See Requirements for Generators Over 1 MW in this Handbook.

2.13.1. Class III Inverter Based DER Requirements

a) Static inverters shall be tested to UL Standard for Inverters, Converters, and Controllers for Use in Independent Power Systems, UL – 1741 by a NRTL certified by OSHA to perform the UL – 1741 test with redundant over/under voltage relay.

2.14. Class IV (Three Phase: ≥ 3 MW) Requirements

2.14.1. DER of this size shall be reviewed on a case-by-case basis.

a) Class IV projects will be subject to technical studies conducted through the Technical Review. These studies can include Feasibility Study, System Impact Study, and Facility Study. SRP shall inform the Customer of the study outcome through the PowerClerk application, which may require modification of the proposed DER facility or electric system upgrades.

b) Additional protection specifications may include a transfer tripping scheme that is communicated via fiber, low voltage ride through capability, and remote-controlled disconnect that enables SRP to isolate the generator from the system.

2.14.2. DER shall operate with a power factor of .95 leading or lagging when interconnected with SRP's electric system.

2.14.3. DER shall be required to provide fault ride through capability and other grid support services as determined by SRP through the Technical Review.

a) It may be determined that DER be equipped with automatic voltage control equipment and normally be operated in voltage control mode. Such systems shall require SRP authorization before operating in other control modes (e.g., constant power factor control).

2.14.4. DER must be rated for 20 MW or less to interconnect to voltages less than 69 kV. Circuit requirements depend on DER size. All SRP electric system upgrades required to support Customer DER interconnection shall be at the Customer's expense. System upgrade requirements and costs are determined in the Technical Review.

2.14.5. The following requirement determines the hosting capacity of an SRP feeder:

a) No more than 10 MW of generation on a dedicated circuit and one dedicated DER circuit per substation transformer. See Requirements for Generators Over 1 MW in this Handbook.

2.15. Protection Devices

2.15.1. Relay Settings

Voltage and frequency relays needed for minimum interface protection for all classes shall have setting ranges as specified by SRP. The Customer must discuss these ranges with SRP prior to designing or installing a DER. For Class III and IV generation units, additional frequency setting requirements are needed to accommodate grid load shedding in accordance with practices of the Western System Coordinating Council.

Voltage and frequency relays needed for minimum interface protection for all classes will have setting limits as specified below.

a) Under-voltage relays shall agree with the latest IEEE 1547 standard (Section 6.4.1, Table 13)

b) Over-voltage relays shall agree with the latest IEEE 1547 standard (Section 6.4.1, Table 13).

c) Over-frequency relays shall agree with the latest IEEE 1547 standard (Section 6.5.1, Table 18).

d) Under-frequency relays shall agree with the latest IEEE 1547 standard (Section 6.5.1, Table 18).

2.16. Utility Right to Change Settings

SRP reserves the right to change or request changes to DER Facility settings based on updated system conditions to maintain system reliability. These setting changes could be made to but not limited to inverter-based resource functionality, protective relays, transfer switches, and communication devices.

2.17. IEEE 1547 Relay Functional Descriptions

2.17.1. Voltage/Frequency Trip: Ability to detect and disconnect for specified thresholds of overvoltage, undervoltage, underfrequency, and overfrequency.

2.17.2. Parallel Synchronization: Voltage and frequency sensing and time-delay functions including:

a) Preventing DER from energizing a de-energized circuit.

b) Preventing DER from reconnecting with SRP's electric system, unless grid system utilization voltage and frequency are within standard nominal voltage range

according to the latest version of ANSI C84.1 Range B: Standard Nominal System Voltages and Voltage Ranges.

c) Preventing DER from reconnecting with SRP's electric system unless it is operating within the SRP specified synchronization parameter limits.

2.17.3. Anti-Islanding: A function to prevent the DER from contributing to the formation of an unintended island and cease to energize SRP's electric system within two seconds of the formation of an unintended island.

2.17.4. Fault Detection: DER shall cease to energize the electric grid for faults on the circuit to which it is connected.

2.17.5. Reclosing Operation: DER shall cease to energize electric grid circuit prior to reclosure by SRP's electric system equipment.

2.18. Uninterruptable Power Supply (UPS)

The Customer shall include an Uninterruptable Power Supply (UPS) or battery bank with a DC to AC inverter for any required Breaker Control Scheme, and any relay to be operational if the normal power source should fail. The UPS shall be capable of supplying backup power for at least eight continuous hours and shall be hard wired (a "plug in" UPS is not acceptable).

3. Application Technical Package Requirements

Schematic diagrams submitted in the DER project application package shall conform with all applicable requirements from Section 2-2: DER System Requirements, within this Handbook, and SRP's Electrical Service Specifications manual.

3.1. Site Plans

Site plan drawings are used to locate facilities, physical configuration, and access across a DER site. These drawings shall indicate all access requirements to the DER site, gate codes, site entrance, service entrance section, Point of Interconnection (POI), DER equipment including generation equipment, meter, and disconnect switches and, when applicable, Restricted Access Switch (RAS) communications cabinet, associated antenna or fiber optic communication return path, additional SRP facilities and space designated for SRP facilities. The plan indicates any site physical structures including adjacent buildings, walkways, towers, or other radio obstructions.

a) Residential Site Plans – For a checklist of what is required on a residential site plan diagram, please find the "Site Plan Checklist" link on: https://www.srpnet.com/doing-business/builders-developers-contractors/info-residential-solar-contractors.

b) Commerical Site Plans – For a list of what must be included on commercial site plans, along with sample site plan diagram examples, please see the "Site plan diagram" section in the application package table found on: https://www.srpnet.com/doing-business/builders-developers-contractors/info-commercial-solar-contractors.

3.2. Interconnection Line Diagrams

All interconnection applications will require one-line and three-line diagrams to be submitted showing the necessary system conductors and connections. One-line diagrams summarize an electrical system at a high level. They can show the major components of the system and how they are connected to each other.

Three-line diagram represents the positive, negative, ground cables of a DC system, and L1, L2, L3 on three phases, neutral, and ground cables of an AC system. The connection from a PV module to an inverter is represented as three lines on a three-line drawing. Three-line diagrams include all neutral and ground conductors and connections.

> EXCEPTION: Applications for residential, single phase interconnections, may submit either a one-line diagram or three-line diagram or both, showing all the system components listed above. SRP reserves the right to ask for additional information or a three-line diagram, if not provided, if there are any safety or access concerns.

a) All electrical line diagrams must show line to load directions from DER sources.

b) Residential Line Diagrams – For a checklist of what is required on residential line diagrams, please find the "Line Diagram Checklist" link on: https://www.srpnet.com/doing-business/builders-developers-contractors/info-residential-solar-contractors.

c) Commercial Line Diagrams – For a list of what must be included on commercial line diagrams, along with sample line diagram examples with additional requirements, please see the "Three-line electrical diagram" and "One-line electrical diagram and relay schematic" sections in the application package table found on: https://www.srpnet.com/doing-business/builders-developers-contractors/info-commercial-solar-contractors.

3.3. Additional Application Technical Documents

For Commerical and Microgrid applications, the following information shall be provided with the Customer's interconnection application in separate documentation, as requested by SRP.

3.3.1. Sequence of Operation (SOO)

a) Detailed description outlining the operation of the DER system and its associated equipment, which shall include but not limited to inverters, controllers, chargers, interconnection system equipment, and transfer switches.

b) Description of device safety guards that prevent unintentional paralleling, islanding, or backfeed, with the Utility EPS.

3.3.2. Power System Analysis

a) Study report that illustrates that the Generating Facility, including the DER site equipment and breakers, are rated to handle short circuit current and interrupting current safely.

3.3.3. Relay Settings for the Generating Facility

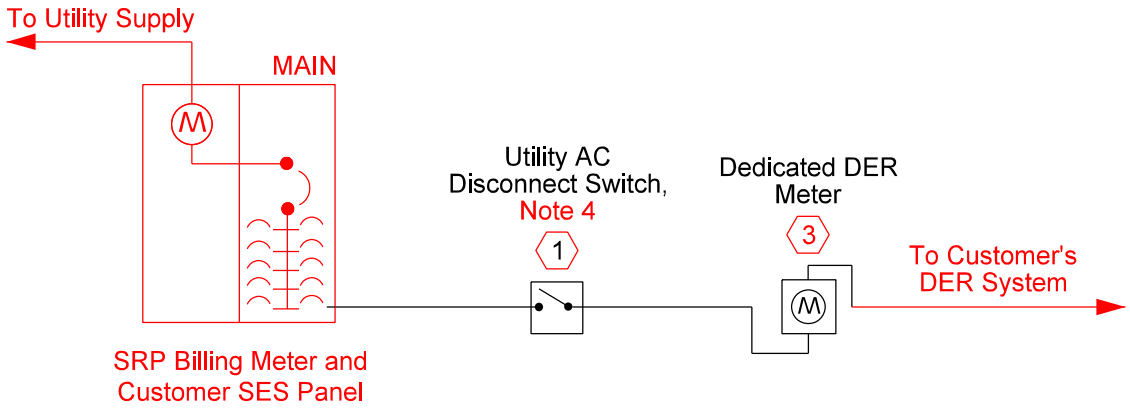
a) Relay settings shall be shared with SRP for review and verification showing that the Generating Facility does not parallel SRP's system for longer than 100ms, along with confirming that SRP's system is not tied together inside the main-tie-main scheme for the plant location.

b) Settings may be reviewed onsite by SRP during commissioning.

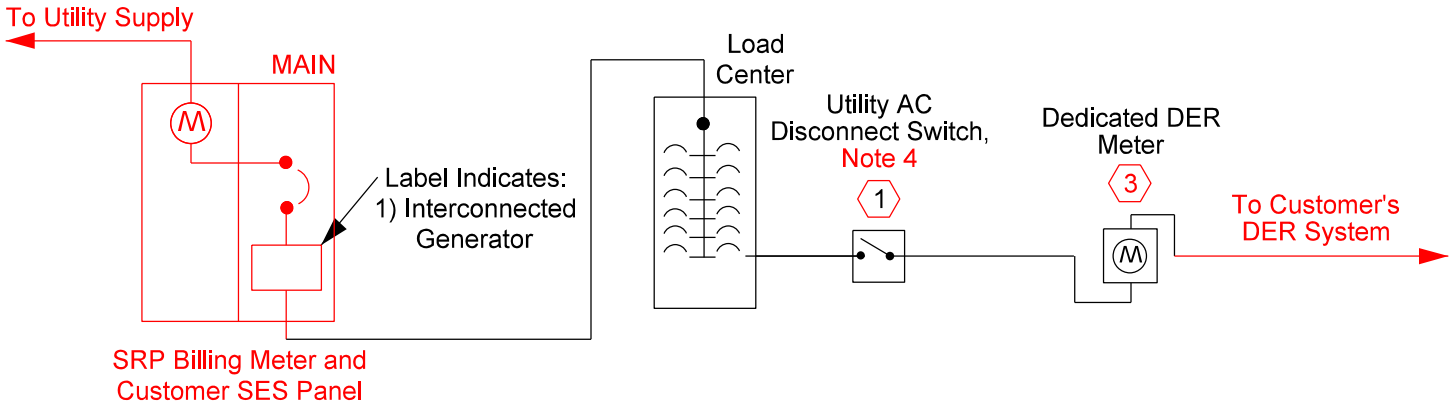
4. Parallel Systems-DER Connection Configurations

The following configurations in this Section illustrate parallel DER connections to SRP's electrical system, as described in Section 2 - 1.6. For non-parallel DER connections, as described in Section 2 - 1.7, please refer to ESS Section 1: Stand-by Generator or Multiple Service and Transfer Switch Requirements.

Typical DER Connection



Load Side Tap

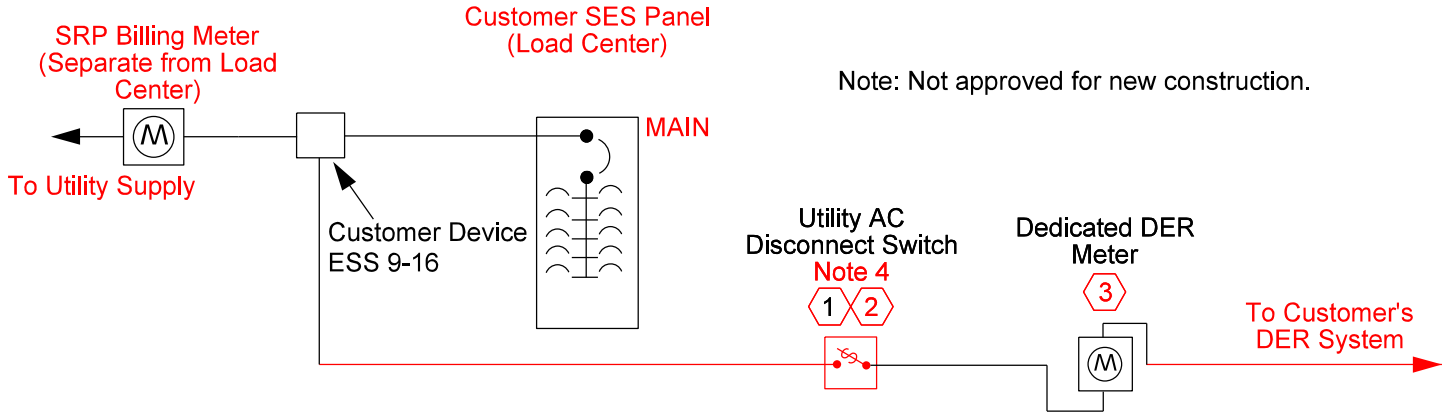


NOTES

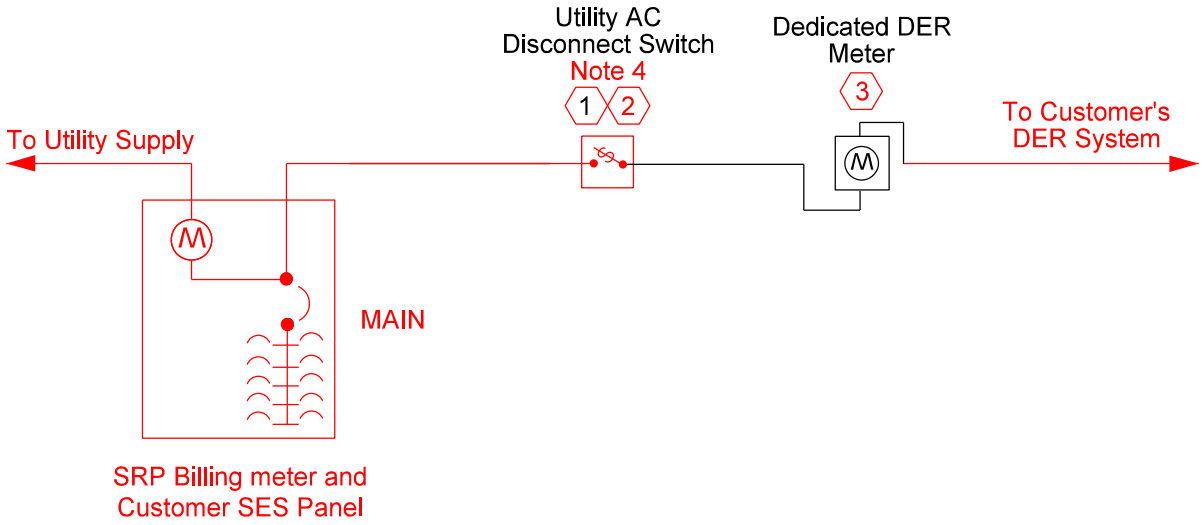
1. For DER Connection Configuration Notes, See Page 2-4-6 within this Handbook.
2. See Secrion 2 - 6.6: DER Signage within this Handbook, for description of label callouts.

LEGEND: ⬡ Equipment Label

Supply Side Tap



Supply Side Tap
All-In-One Service



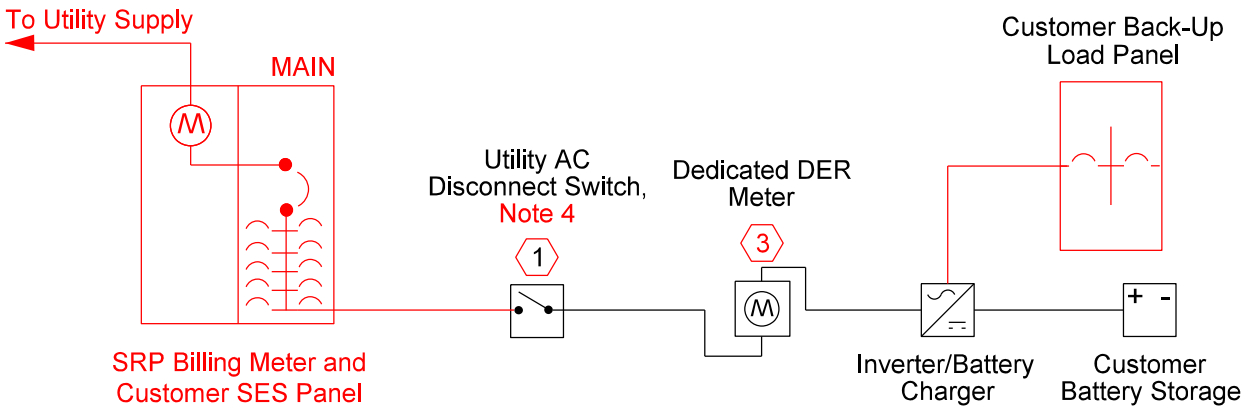
NOTES

1. For DER Connection Configuration Notes, See Page 2-4-6 within this Handbook.
2. See Secrion 2 - 6.6: DER Signage within this Handbook, for description of label callouts.

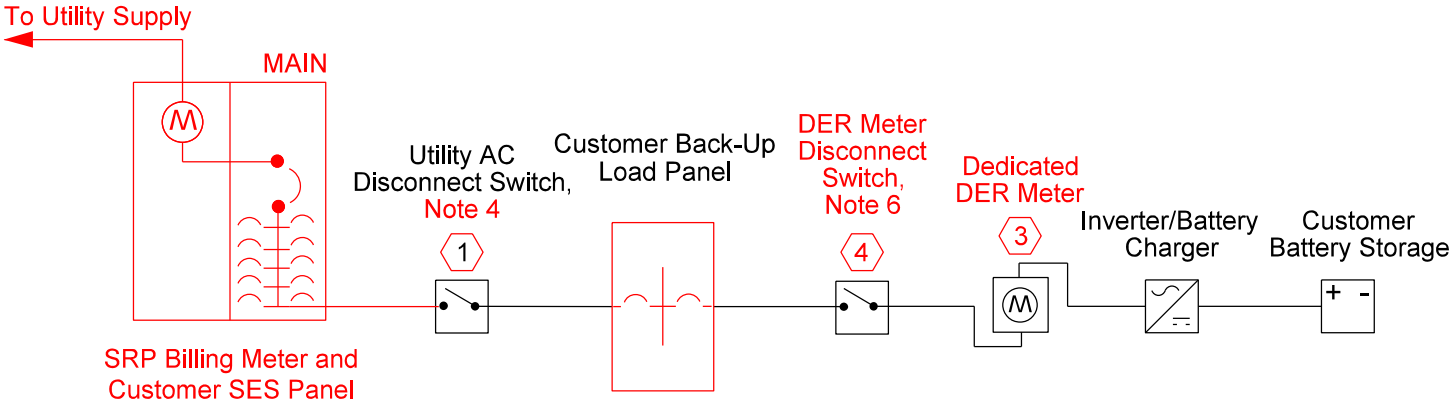
LEGEND: ⬡ Equipment Label

Configurations 4.1 - AC Coupled System, DER Storage Only

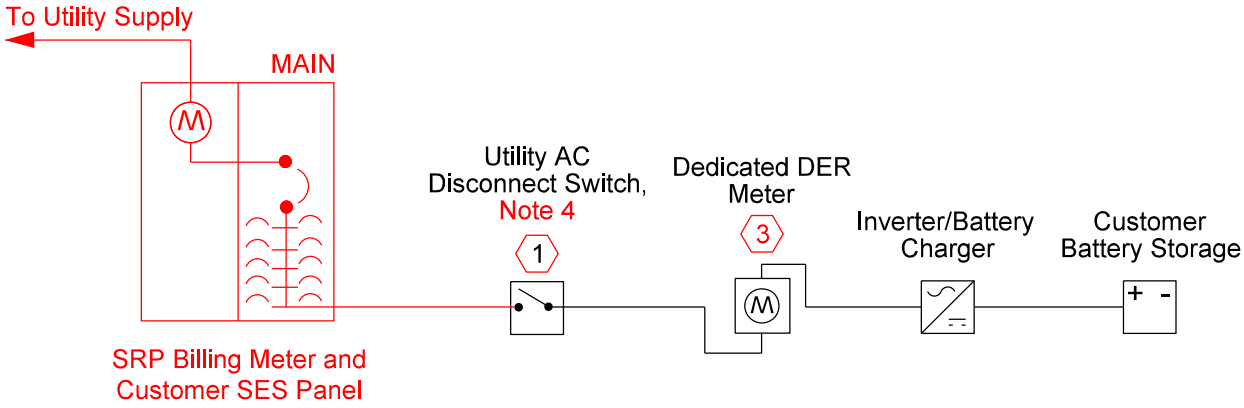
Configuration 1A. With Back-Up Load Panel



Configuration 1B. With Back-Up Load Panel Alternate Configuration



Configuration 1C. No Back-Up Load Panel



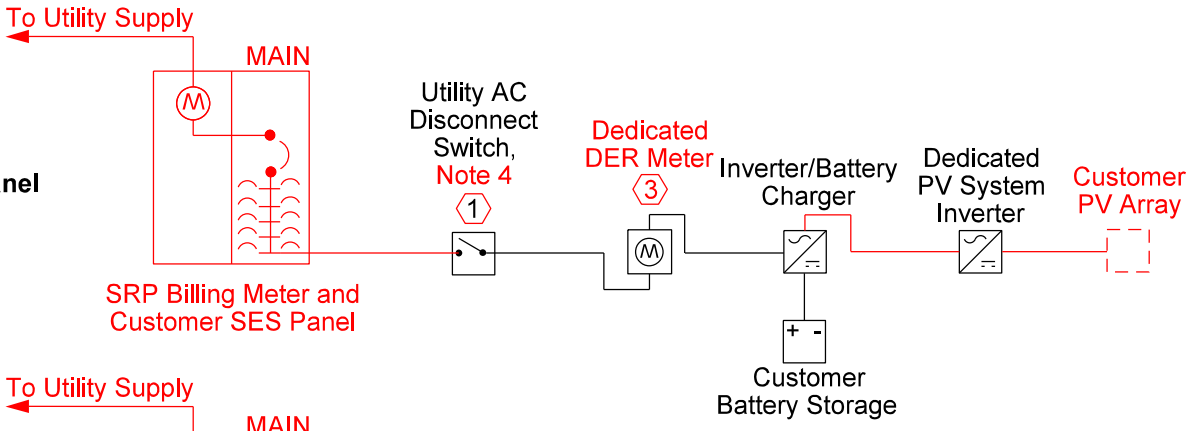
NOTES

1. For DER Connection Configuration Notes, See Page 2-4-6 within this Handbook.
2. See Secrion 2 - 6.6: DER Signage within this Handbook, for description of label callouts.

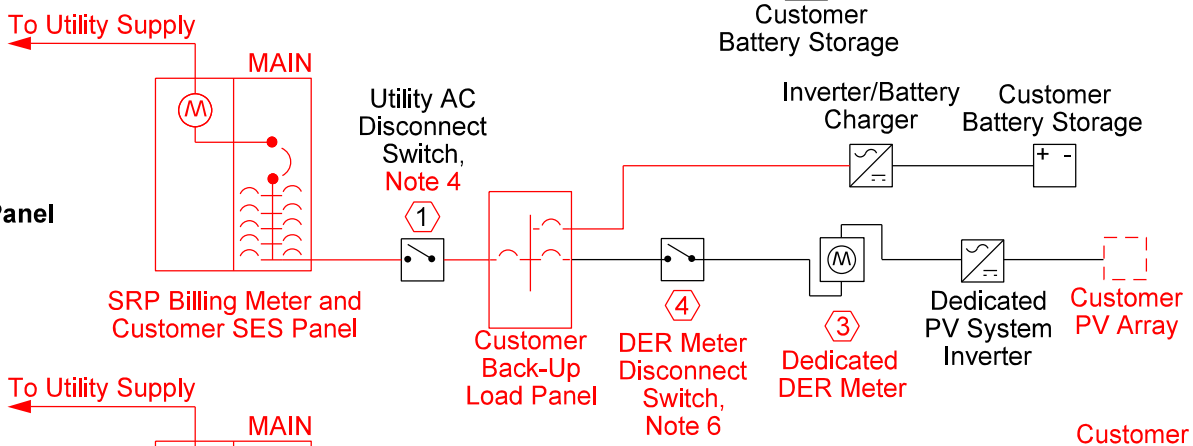
LEGEND: ⬡ Equipment Label

Configurations 4.2 - AC Coupled System with DER Solar + Storage

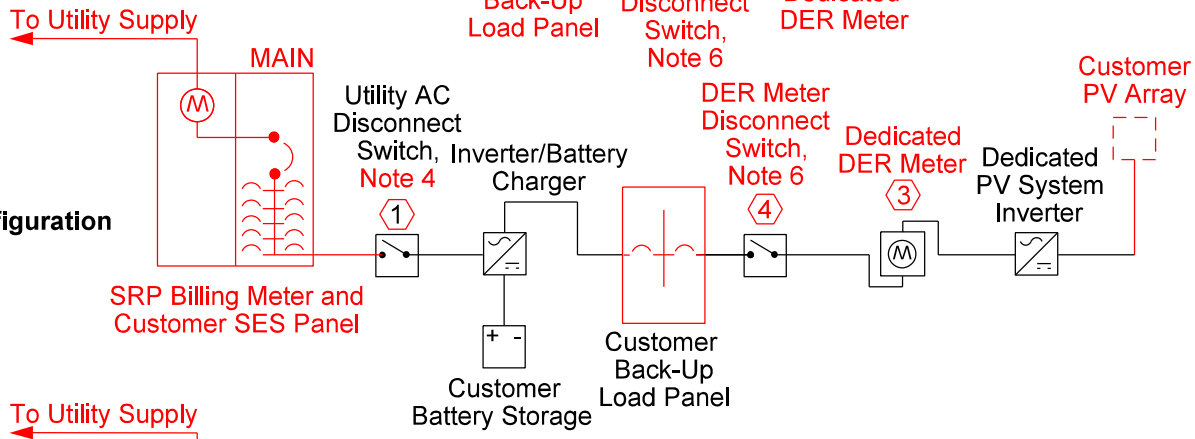
Configuration 2A.
No Back-Up Load Panel



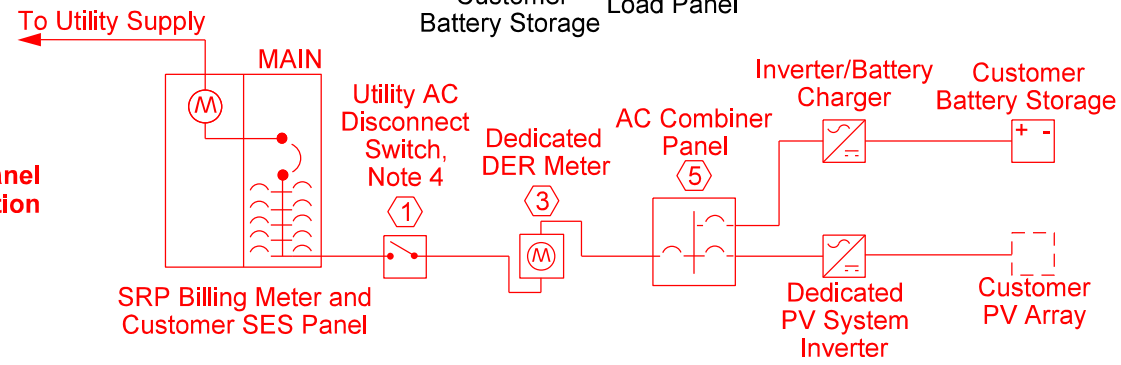
Configuration 2B.
With Back-Up Load Panel



Configuration 2C.
With Back-Up Load Panel Alternate Configuration



Configuration 2D.
No Back-up Load Panel
Alternate Configuration



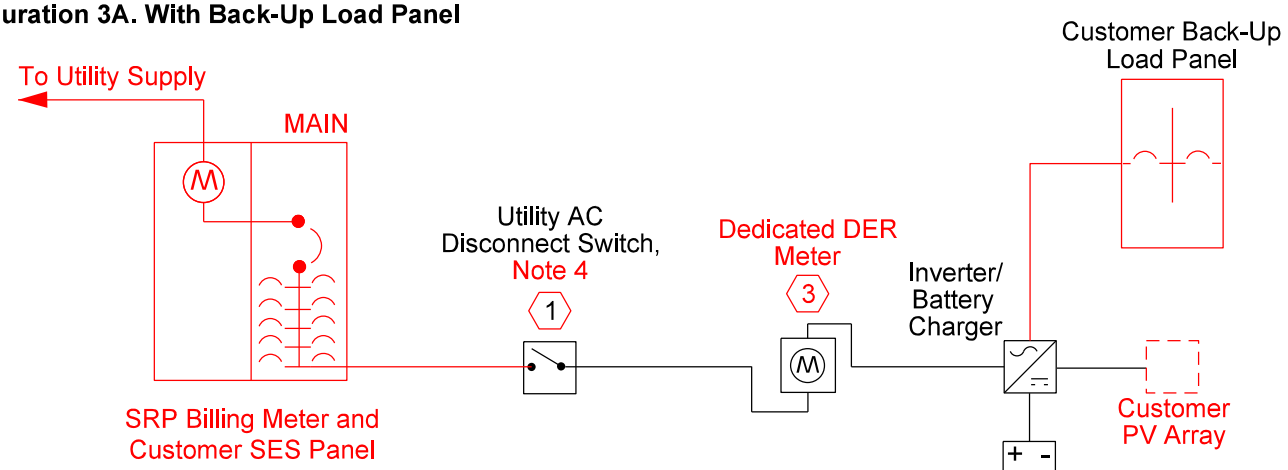
NOTES

1. For DER Connection Configuration Notes, See Page 2-4-6 within this Handbook.
2. See Secrion 2 - 6.6: DER Signage within this Handbook, for description of label callouts.

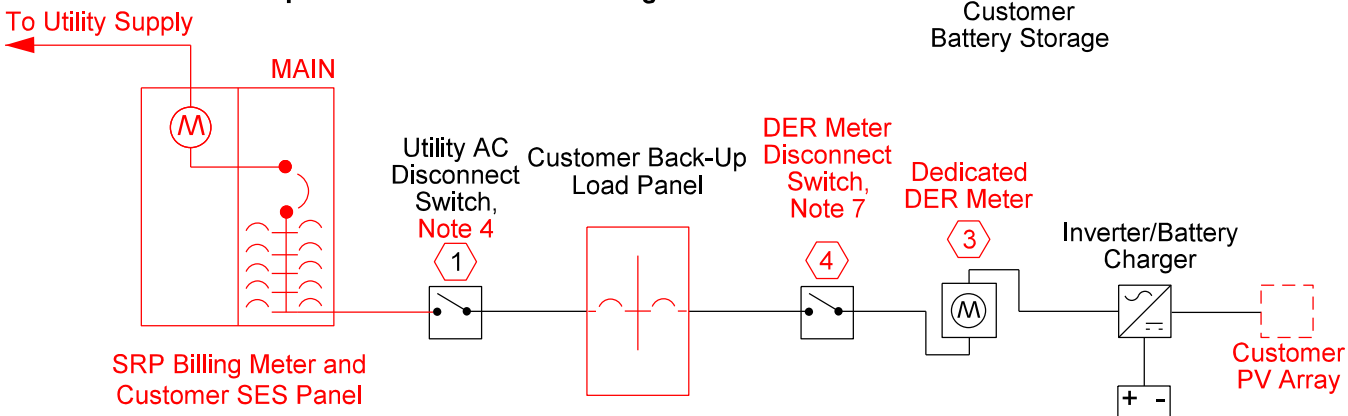
LEGEND: ⬡ Equipment Label

Configurations 4.3 - DC Coupled System with DER Solar + Storage

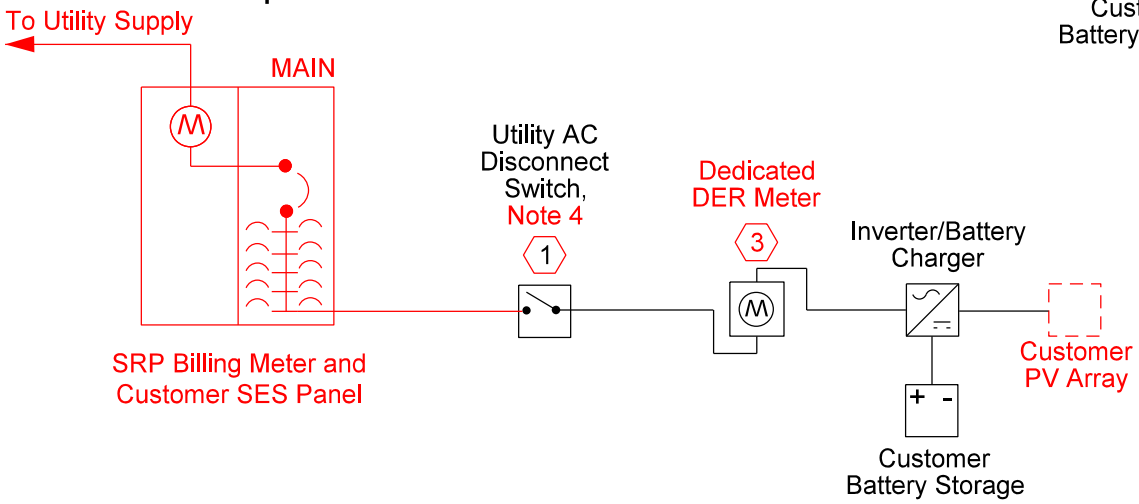
Configuration 3A. With Back-Up Load Panel



Configuration 3B. With Back-Up Load Panel Alternate Configuration



Configuration 3C. No Back-Up Load Panel



NOTES

1. For DER Connection Configuration Notes, See Page 2-4-6 within this Handbook.
2. See Secrion 2 - 6.6: DER Signage within this Handbook, for description of label callouts.

LEGEND: ⬡ Equipment Label

NOTES

1. All Customer equipment shall be installed, maintained, and modified by the Customer in accordance with the requirements of the local AHJ, NEC and SRP. In those areas where the AHJ does not provide a city clearance, the Customer must provide a signed Certificate-in-Lieu of Clearance following the completion of all work. See SRP's ESS for a sample of the certificate.

   a) For design drawings that do not follow SRP standards, SRP reserves the right to request in writing that the design drawings be stamped by an Electrical Professional Engineer (PE) registered in the State of Arizona. All design drawings for a DER site greater than 300 kW, must be stamped by an Electrical PE registered in the State of Arizona.

2. The utility AC disconnect switch, dedicated DER meter, and associated DER system disconnect switch, shall be grouped together within a maximum distance of 10' of the SES for residential DER Facilities or within 30' of the SES for commercial DER Facilities, with no obstructions (sharing a common corner of the structure is allowed) and is readily accessible as required in ESS Section 5: Clearances and ESS Section 9: Metering & SES.

   EXCEPTION: If conditions prohibit grouping the SES, utility AC disconnect switch, dedicated DER meter, and associated DER system meter disconnect switch together per the maximum distance described above, these facilities may be remotely located with SRP and AHJ approval. The remote location must be readily accessible, as required in ESS Section 5: Clearances and ESS Section 9: Metering & SES. The SES shall have signage, including a site map, indicating the interconnected generator(s), along with the specific location of the dedicated DER meter(s) and associated disconnect switch(es), as applicable.

   a) If the SES is upgraded, consult a SRP Design representative.

3. The utility AC disconnect switch, dedicated DER meter, associated DER system disconnect switch, and Customer-fused disconnect switch (if installed), shall be a minimum 36" from any natural gas vent. Conduits, disconnect switches and meter sockets shall not be used as a raceway for any additional facilities not associated with the electrical interconnection of the DER system.

4. The utility AC disconnect switch shall be connected between the SES and DER system as shown. A Customer-fused disconnect switch required for residential and commercial DER systems, with a short circuit rating greater than 10 kA, shall be connected between the SES and utility AC disconnect switch. The Customer-fused disconnect may be separate from the utility AC disconnect or integrated as a single device.

5. Utility AC disconnect switch, NEMA 3R or better, shall have visible moveable blades with provisions for locking the door closed and locking the operating handle (blades) and fuse holder (when required) open with an SRP lock only. Door shall be secured with an SRP-supplied Customer access padlock (CAP) and key for Customer access. Refer to Section 2 – 2.6: System Disconnect Switches in this Handbook for more information.

6. For AC coupled DER systems utilized to serve a Customer back-up load panel, a DER meter disconnect switch shall be connected between the dedicated DER meter and Customer back-up panel as shown. DER meter disconnect switch, NEMA 3R or better, shall have visible movable blades with provisions for locking the door closed and locking the operating handle (blades) open with an SRP lock only.

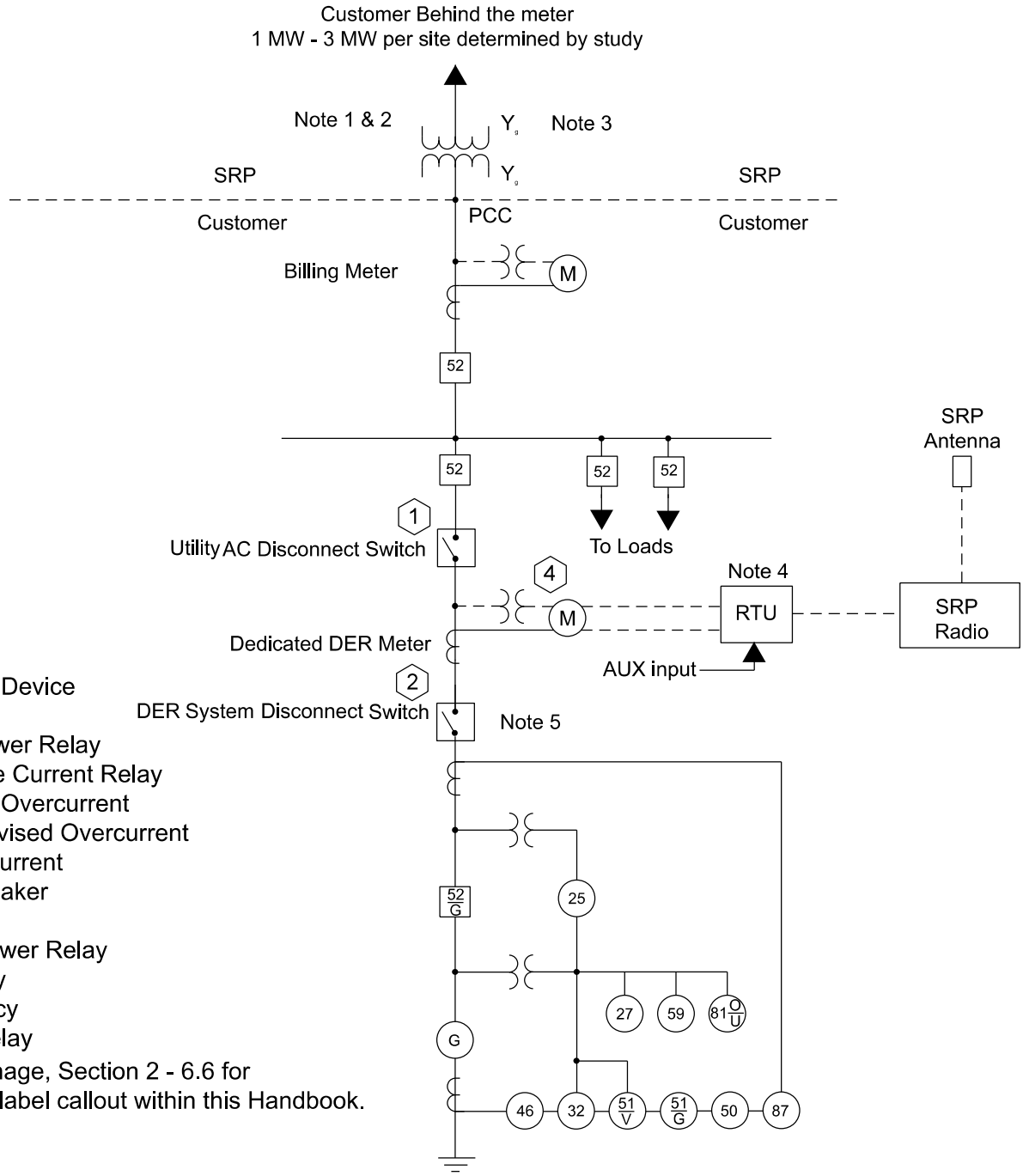
7. For DC coupled DER systems utilized to serve a Customer back-up load panel, a DER meter disconnect switch shall be connected between the dedicated DER meter and Customer back-up load panel as shown. DER meter disconnect switch, NEMA 3R or better, shall have visible movable

blades with provisions for locking the door closed and locking the operating handle (blades) open with an SRP lock only.

8. Disconnect switch shall have adequate spacing for operation and the ability to install locks on the door and handle.
9. DER systems with storage or emergency generators utilized to serve a Customer back-up load panel will require an automatic transfer switch (ATS) or microgrid interconnection device (MID) to isolate the Customer back-up load panel in the event of a system outage. See ESS 1-23: Stand-by Generator or Multiple Service and Transfer Switch Requirements. The Customer is responsible for selecting and installing any devices required to affect this transfer. The ATS may be integrated into the Interconnection System Equipment or may be a separate device.
10. Customer shall provide site plans and electrical line diagrams to SRP that includes, but not limited to: location of SES, utility AC disconnect switch, dedicated DER meter(s), associated DER system disconnect switch(es), and manufacturer data. See Section 2 – 3: Application Technical Package Requirements within this Handbook, for more detailed information regarding these requirements.
    a) SRP requires a label sheet based on the equipment shown on the electrical line diagram(s).
    b) Inverter and interconnection system equipment, must comply with the latest version of UL 1741 / UL 1741 SA.
11. No load taps shall be allowed between the DER system and the AC or DC coupled dedicated DER meter socket. All DER inverters shall be connected to the line side connection points of any associated meter.

    EXCEPTION: Customer back-up load panel is allowed to be tapped between the DER system and dedicated DER meter socket.
12. The voltage rating, phase and number of wires of the DER system, shall be equal to the SES. Use of single-phase inverters on a three-phase service may be allowed. Consult a SRP Design representative.
13. For labeling requirements, refer to Section 2 – 6.6: DER Signage within this Handbook.

4.4. Class III Synchronous Generator



LEGEND

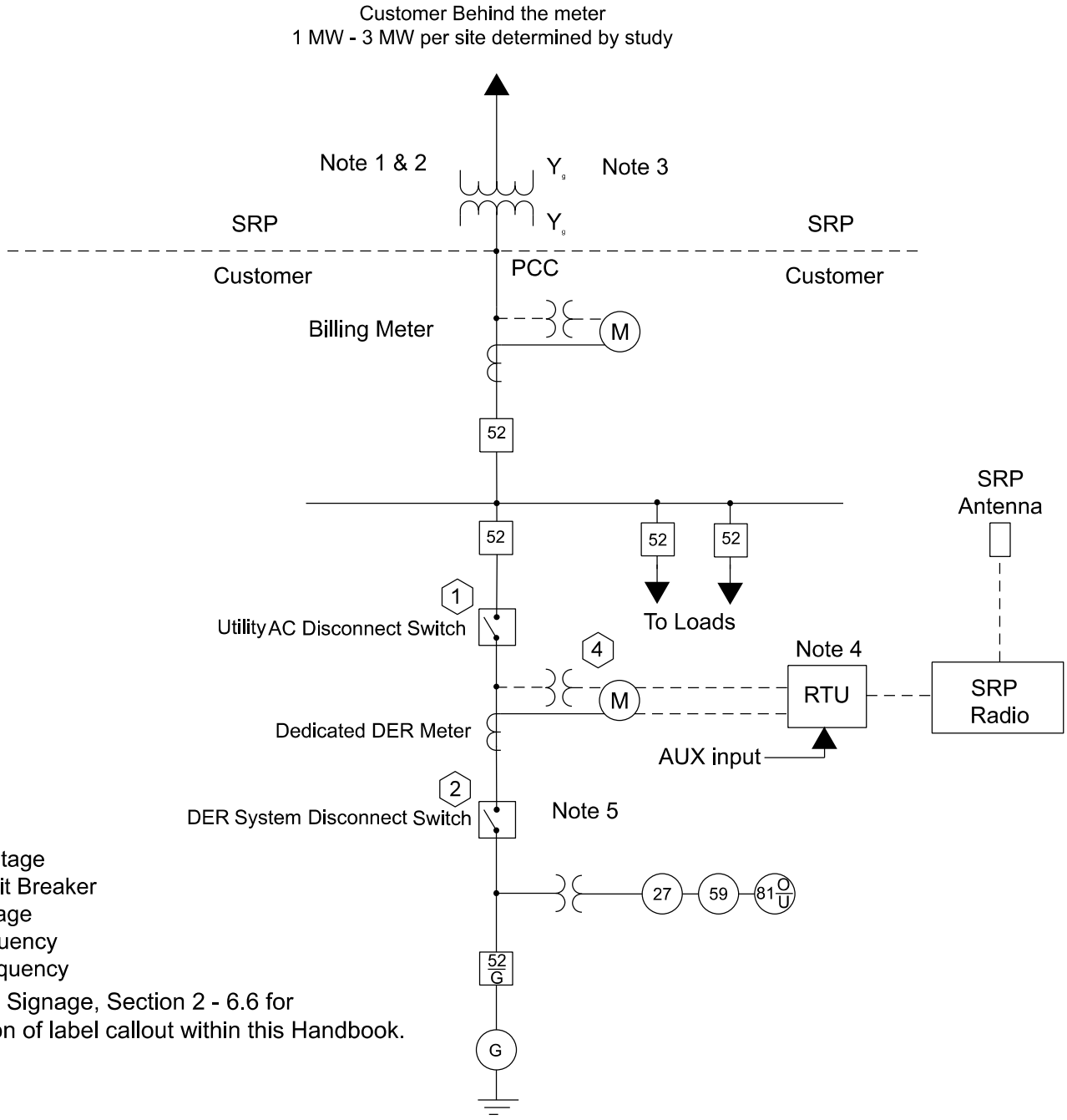
25 Synchronizing Device
27 Undervoltage
32 Directional Power Relay
46 Phase Balance Current Relay
50 Instantaneous Overcurrent
51V Voltage Supervised Overcurrent
51G Ground Overcurrent
52 AC Circuit Breaker
59 Overvoltage
32 Directional Power Relay
81O Overfrequency
81U Underfrequency
87 Differential Relay

⬡ See DER Signage, Section 2 - 6.6 for description of label callout within this Handbook.

NOTES

1. Refer to Requirements Applicable to All DER Types in this Handbook. Section 2 - 2.2.
2. Refer to DER Protection Requirements by Class in this Handbook. Section 2 - 2.9.
3. SRP preference is a Yg-Yg transformation, and if different the system will be subject to additional requirements.
4. Refer to Requirements for Generators 1 MW and Over in this Handbook. Section 2 - 7
   Telemetering device shall have AUX power provided by the customer.
5. Refer to System Disconnect Switches in this Handbook. Section 2 - 2.7.

4.5. Class III Inverter Based Generator



LEGEND

27 Undervoltage
52 AC Circuit Breaker
59 Overvoltage
81O Overfrequency
81U Underfrequency

⬡ See DER Signage, Section 2 - 6.6 for description of label callout within this Handbook.

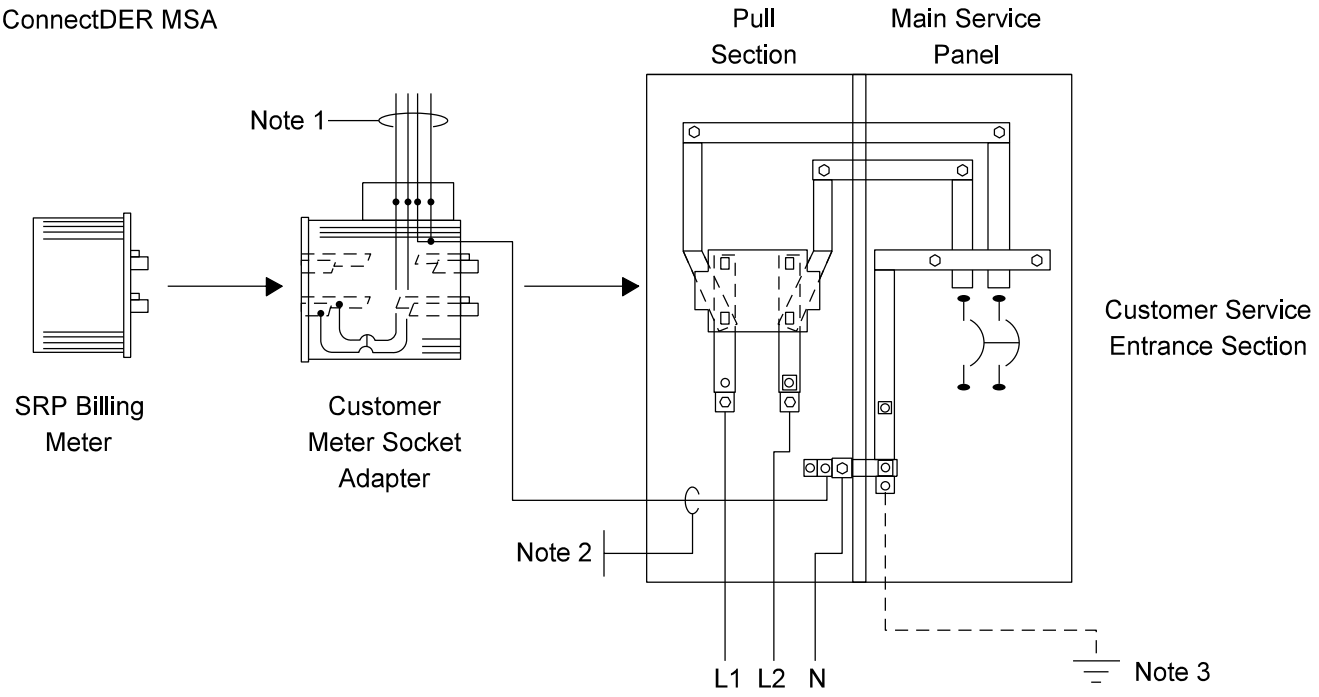
NOTES

1. Refer to Requirements Applicable to All DER Types in this Handbook. Section 2 - 2.2.
2. Refer to DER Protection Requirements by Class in this Handbook. Section 2 - 2.9.
3. SRP preference is a Yg-Yg transformation, and if different the system will be subject to additional requirements.
4. Refer to Requirements for Generators 1 MW and Over in this Handbook. Section 2 - 7.
   Telemetering device shall have AUX power provided by the customer.
5. Refer to System Disconnect Switches in this Handbook. Section 2 - 2.7.

4.6 MSA Installation Diagrams

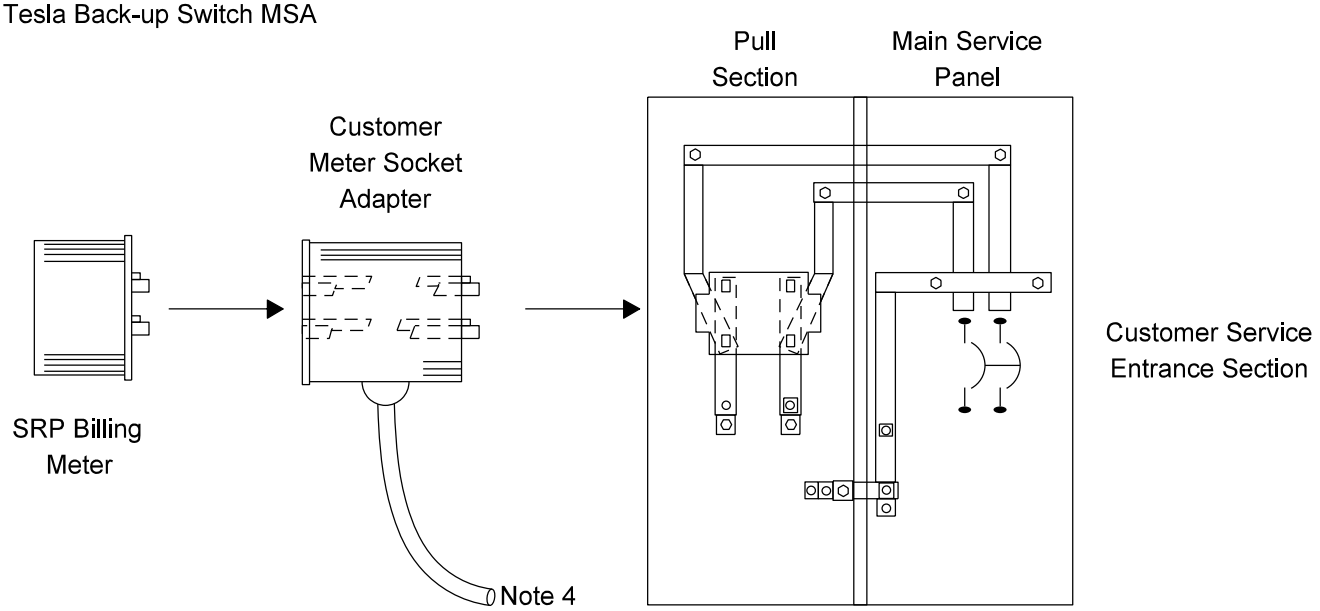
MSA 1A. For interconnecting power production of a Generating Facility.

Example: ConnectDER MSA



MSA 1B. For whole-home electric isolation and (intentional or unintentional) islanding of a Generation Facility.

Example: Tesla Back-up Switch MSA



NOTES

1. String or micro-inverter output conductors (L1, L2, N). Ground PV system per manufacturer recommendations and in accordance with local codes and practices.
2. Terminate neutral pigtail in the pull section of the SES. The neutral pigtail shall not be stacked with the system neutral in the pull section and shall not be terminated on the Customer's side of the service (main service panel) where the neutral and ground are bonded together.
3. Grounding electrode.
4. Communication cable connected to DER system controller.

5. Operation and Maintenance Requirements

5.1. Inspections, Testing, and Maintenance

5.1.1. The Customer shall be responsible for operating and maintaining the DER in accordance with the requirements of all applicable safety and electrical codes, laws, and governmental agencies having jurisdiction.

5.1.2. The Customer is solely responsible for conducting and documenting proper periodic maintenance per the manufacturer's recommendations on the generating equipment and its associated control, protective equipment, interrupting devices, and disconnect switch.

5.1.3. The Customer shall keep a written log and test records showing the periodic testing of DER equipment. These records must be available to SRP upon request.

5.1.4. All systems approved for operation in SRP service territory may be subject to an SRP inspection.

5.1.5. Protective devices installed on Customer side of facilities need to be tested annually or by maintenance schedules specified by the manufacturer and agreed upon by SRP. A record of test results shall be maintained by the Customer, and inspection or observation by SRP shall be scheduled as required.

5.1.6. SRP may request witnessing of functional trip tests on an annual basis. When requested, the Customer shall notify SRP when such tests are to be performed at least seven calendar days prior to such tests, and allow SRP personnel to witness the testing. In addition, SRP may annually request that all protective devices be field tested and calibrated by qualified personnel, and that written copies of the results be provided to SRP.

5.1.7. SRP, including its employees, agents and representatives, shall have the right to enter the DER site for the following:

a) Inspect the Customer's DER, protective devices, and to read or test instrumentation equipment that SRP may install, provided that reasonable advance notice is given to the Customer prior to entering its premises.

b) Maintain or repair SRP equipment.

c) Disconnect the DER without notice if, in SRP's opinion, a hazardous condition exists and such immediate action is necessary to protect persons, SRP facilities or other Customers' or third parties' property and facilities from damage or interference caused by the Customer's generating facility, or improperly operating protective devices.

d) Open the disconnect switch without notice if SRP personnel require an operating clearance or hold tag.

Annual inspections of the DER facility are recommended. These must always be conducted by licensed professionals.

5.2. Replacement of Major Equipment

The owner/operator shall inform SRP of planned replacement(s) of the inverter(s), or other major electrical equipment. If the changes are significant to the output of the interconnection, a new application and study may be required. No replacement shall be undertaken until SRP has been notified and approved the changes.

5.3. Physical and Cyber Security

DER facilities can be subject to malicious physical tampering, sabotage, and cyber-attacks. The Customer shall maintain good security practices regarding DER hardware and software. Facility hardware shall not be readily accessible and strong passwords must be assigned and maintained by the Customer for any device area network. Equipment must always be registered with the manufacturer. Networked device default passwords and firmware reset shall be secured, abstracted, or made inaccessible.

5.4. Hold Tags & Clearances

SRP uses hold tags to protect equipment. See Glossary for Hold Tag. SRP will open, lock & tag the appropriate disconnect switch on non-inverter based DERs, when a hold tag is issued for the supplying circuit. When a Clearance is required SRP will open, lock & tag the appropriate disconnect switch on all DERs.

Following the release of an SRP clearance or hold tag, where it was necessary for SRP to open the Utility AC disconnect switch, SRP personnel will not normally close the switch. It shall be the Customer's responsibility to close the switch after ensuring that all generation sources are synchronized with the utility.

5.5. Hold Tag Process Flow Chart

Figure 1: Hold Tag Process Flow Chart

6. Miscellaneous

6.1. Grounding Circuits and Substations

Grounding system equipment provides a suitable pathway for fault currents to dissipate through the ground as quickly as possible and keeps the electric grid protected from surges and faults. The grounding scheme of the interconnection transformer shall not cause over voltages on the un-faulted phases during ground-fault conditions that exceed the rating of equipment connected to SRP Electric System. Correct grounding at a facility and on the SRP Electric System enables safe and reliable operation.

Refer to ESS Section 8: Grounding and Bonding.

6.2. Right-of-Way, Transmission Line Crossing Policy, Infrastructure Property Requirements

The Customer must acquire the necessary right-of way for their interconnection including access requirements to the POI with SRP's facilities. The use of SRP right-of ways and/or property shall not be included in any interconnection proposals.

6.3. Disconnecting Service

SRP reserves the right to disconnect a DER from the its electric system . This allows SRP to maintain the operational integrity of the electric system and to continue to safely and reliably provide electric energy to the public.

SRP may refuse to connect or may disconnect a DER from the electric system if any of the following conditions apply:

a) Lack of fully executed Interconnection Agreement (IA)

b) Termination of interconnection by mutual agreement

c) Noncompliance with technical or contractual requirements in the Interconnection Agreement after notice is provided to the Customer of the technical or contractual deficiency

d) Unauthorized changes to the interconnection

e) Distribution system emergency

f) Routine maintenance, repairs, and modifications, for a reasonable length of time necessary to perform the required work.

6.4. Smart Inverters

6.4.1. Inverter Requirements

Inverter-based systems must demonstrate compliance with all requirements of the latest version of the UL1741 SA "Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources" by manufacturer certification. Non-certified inverters shall be tested in accordance with the latest version of IEEE 1547 and comply with SRP ESS and Interconnection Handbook requirements.

SRP follows the CPUC approved equipment lists. These inverters are all UL 1741 SA listed and CA Rule 21 compliant.

Where there are long conductor runs between the inverter(s) and the service entrance, there is a possibility of a voltage rise at the inverter terminals sufficient to cause nuisance tripping, even when the service entrance voltage is within normal limits. It is the responsibility of the Customer to account for this possibility in designing the interconnection facilities.

6.5. Field-Enabled Settings

Smart Inverter settings shall be dictated by SRP and may be verified on-site prior to granting permission to operate. If SRP determines that the DER is negatively impacting power quality on Customer's circuit, SRP may adjust inverter settings or require operational control to achieve levels acceptable to SRP.

The settings identified within this section shall be adopted by all interconnectors regardless of size, unless site specific mutually agreed upon settings are defined within the interconnectors Interconnection Agreement.

All inverters shall be interconnected with the Category B settings for normal operation, and Category III settings for abnormal response and performance. These Categories are defined within the latest version of IEEE Std. 1547.

Table 2: SRP Required Settings for All Interconnectors

IEEE 1547-2018 Reference	Setting Name	Status	Set Points
4.10	Enter Service Criteria	Enabled	Category B Default
5.3.2	Constant Power Factor Mode	Disabled	-
5.3.5	Constant Reactive Power Mode	Disabled	-
5.3.3	Volt-VAR Mode	Enabled	Category B Default
5.3.4	Watt-VAR Mode	Disabled	-
5.4.2	Volt-Watt Mode	Enabled	Category B Default
6.4.1	Mandatory Voltage Tripping	-	Category III Default
6.4.2.1	Mandatory Voltage Ride Through	-	Category III Default
6.5.1	Mandatory Frequency Tripping	-	Category III Default
6.5.2.1	Mandatory Frequency Ride Through	-	Category III Default
6.5.2.7.2	Frequency Droop	Enabled	Category III Default
8.1	Unintentional Islanding	Enabled	IEEE 1547 Setting Default (latest version)
10.7	Communication Protocol	-	IEEE Std. 1815 (DNP 3)

- Any empty cells are intentionally left blank as there is only a single selection required to follow the above table

Below are brief descriptors of the settings listed above, for more information see corresponding reference within the latest version of IEEE 1547 as listed in the table above:

a) Enter Service Criteria – By enabling this setting at the defined set points, the inverter shall only connect when voltage being measured by the inverter is between safe limits defined by the latest version of IEEE Std. 1547.

b) Constant Power Factor Mode – This has been disabled to allow for Volt-VAR Mode to be enabled.

c) Constant Reactive Power Mode – This has been disabled to allow for Volt-VAR Mode to be enabled.

d) Volt-VAR Mode – By enabling this setting at the defined set points, the inverter will provide reactive power support during minor abnormal system voltage deviations.

e) Watt-VAR Mode – This has been disabled due to Volt-VAR Mode being enabled.

f) Volt-Watt Mode – By enabling this setting at the defined set points, the inverter will remain connected to SRP's system beyond the standard requirement to entirely disconnect due to rare high voltage events. During these high voltage events the inverter will temporarily curtail real power output to remain connected to the system.

g) Mandatory Voltage Tripping – These are set limits defined by Category III identifying when an inverter shall trip based on high and low voltage measured at the inverter.

h) Mandatory Voltage Ride Through – These are set parameters defined by Category III identifying during high and low voltage events how the inverter shall respond by remaining connected for a set amount of time before disconnecting based on measured voltages.

i) Mandatory Frequency Tripping – These are set limits defined by Category III identifying when an inverter shall trip based on high and low frequency measured at the inverter.

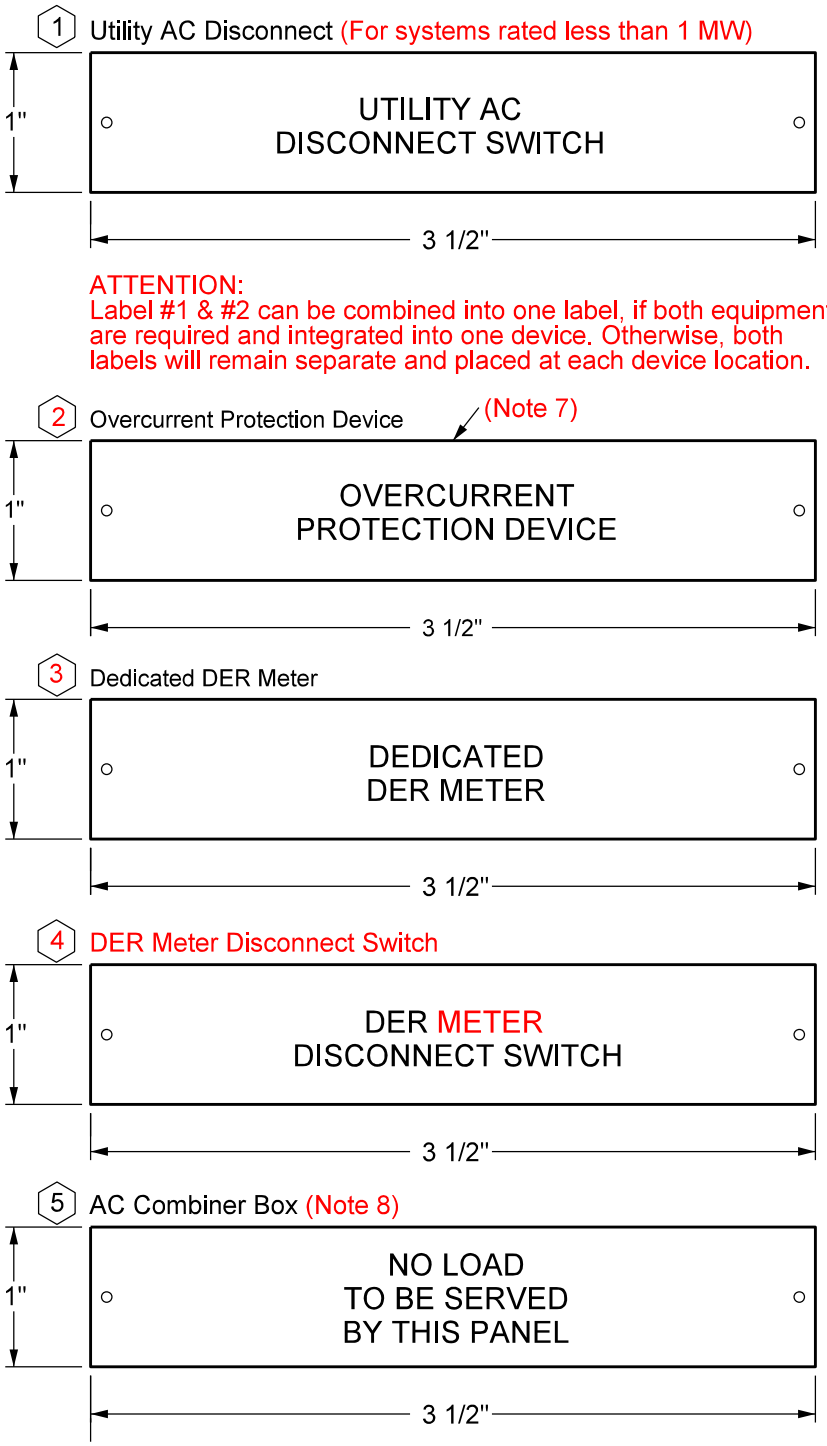
j) Mandatory Frequency Ride Through - These are set parameters defined by Category III identifying during high and low frequency events how the inverter shall respond by remaining connected for a set amount of time before disconnecting based on measured frequency.

k) Frequency Droop – By enabling this setting at the defined set points, the inverter shall coordinate with SRP protection settings if system frequency events occur, the response will temporarily curtailment real power.

l) Unintentional Islanding – By enabling this setting the inverter shall utilize increased sensitivity during a potential island event due to a larger system disturbance and disconnect as a safety precaution until normal service has been restored.

m) Communication Protocol – SRP requires the capability of communication to the inverter via DNP3 communication protocol. SRP will not utilize this functionality without mutual agreement between the Customer and SRP.

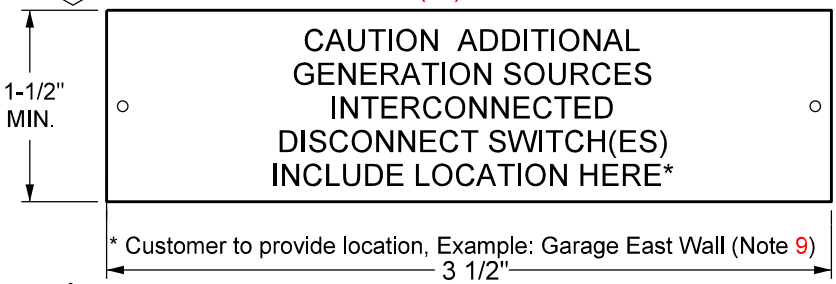
6.6 DER Signage



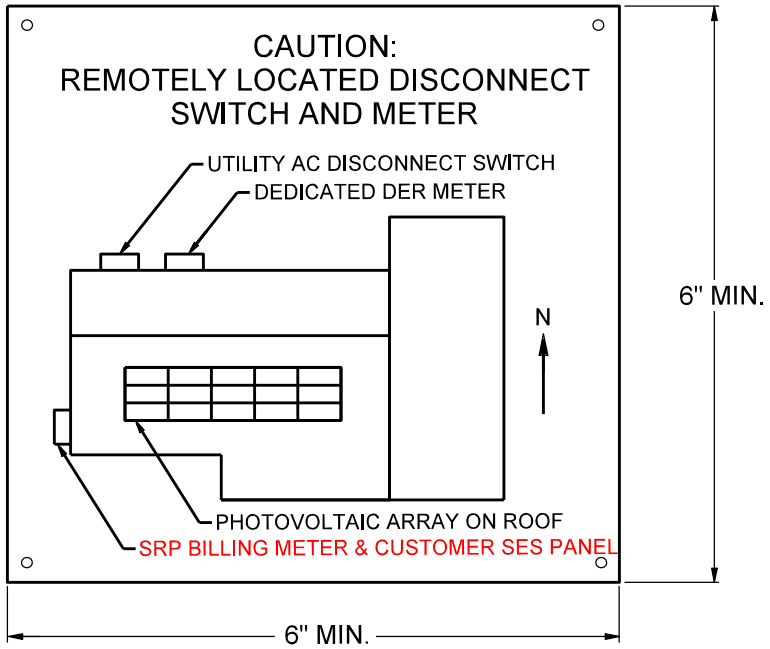
NOTES

1. For all other contractor supplied material and additional labeling, see ESS Section 11: Contractor Supplied Material.

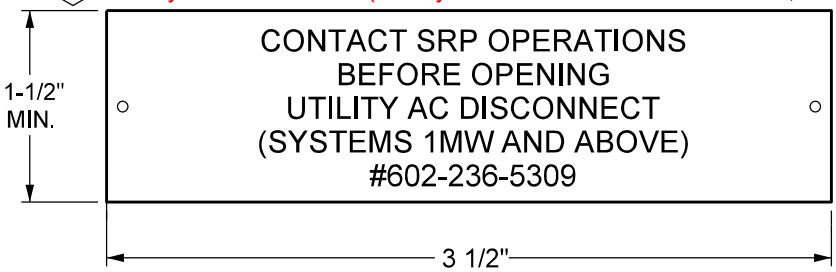
6 SES Signage Indicating Location of Remote DER Meter (s) and/or Disconnect Switch (es)



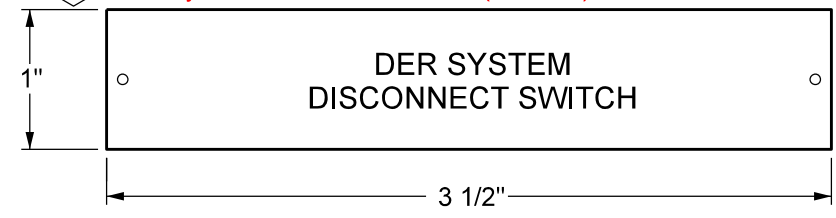
7 DER Site Map Example (Note 9)



8 Utility AC Disconnect (For systems rated 1 MW and above, Note 10)



9 DER System Disconnect Switch (Note 11)



NOTES

1. For all other contractor supplied material and additional labeling, see ESS Section 11: Contractor Supplied Material.

Distributed Generation Interconnection Handbook PROPRIETARY MATERIAL	REV: REARRANGE AND UPDATED LABELS	
	CONTRACTOR - SUPPLIED MATERIAL DISTRIBUTION ENERGY RESOURCE (DER) SIGNAGE	ISSUE DATE: 05/10/21 REV. DATE: 01/08/25 APPROVAL: C. OBRIEN
	2-6-5	8523E019.DGN

Approved Suppliers
Bazzill Engraving Company
(PH # 602-437-9019)

NOTES

1. All labels shall be readily visible and shall not be installed on any removable or hinged cover panel.
2. Dymo type as described in ESS Section 9-10: SES Addressing and Identification.
3. Signs shall be pop-riveted to Front Face of cabinet as shown in diagrams.
4. Signs are stainless steel, 0.015" thick (min.) or aluminum 0.059" thick (min.) with raised or impressed letters 0.01" min depth. Capital letters 3/16" min depth.
5. All pop-rivet holes are 1/8" diameter (typ.).
6. Multiple services, meters, or disconnects shall be identified. Identification means shall be in such a manner as Meter 1-3, 2-3, 3-3, etc. For more information regarding labeling, see ESS Section 9-10: SES Addressing and Identification.
7. Overcurrent Protection labeling is required for all fused Utility AC Disconnect Switches or on the fused disconnect if the AC Utility Disconnect Switch and the fused disconnect are separate.
8. Signage for an AC Combiner Box and Remote Load Center are only required if these options are utilized.
9. If conditions prohibit grouping the SES, Utility AC Disconnect Switch, Dedicated DER Meter, and associated DER System Disconnect Switch together, these facilities may be remotely located with SRP and AHJ approval. The SES shall have signage, including a site map, indicating the interconnected generator(s), along with the specific location of the Dedicated DER Meter(s), and associated Disconnect Switch(es), as applicable. See Section 2.7: System Disconnect Switches within this Handbook. The site map shall be red 3M Impact Acrylic (or equivalent) and comply with AHJ requirements. Letters shall be engraved 0.01" min depth. Capital letters 3/16" min depth. Indicate north arrow as shown.
10. On systems 1 MW and above, the preferred location for the label is near the Utility disconnect operating handle.
11. For DER facilities that require a DER System Disconnect Switch, see Section 2 - 2.8: System Disconnect Switches within this Handbook, for more information.
12. For all other contractor supplied material and additional labeling, see ESS Section 11: Contractor Supplied Material.

7. Requirements for Generators 1 MW and Over

7.1. Supervisory Control and Data Acquisition (SCADA) Requirements

SCADA is the collection of operational information from the electric grid. SCADA can include data such as voltage, amperage, power, and the status of equipment such as circuit breakers and switches. In addition to monitoring the grid, SCADA equipment also allows SRP to operate and control the electric system, such as opening and closing circuit breakers or switches. SCADA is required for SRP to safely and reliably monitor and operate the electric system.

7.1.1. SCADA Equipment

At the Customer's expense, SRP shall purchase, configure, install, and commission a Remote Terminal Unit (RTU). The size and point count of the RTU is determined by the DER nameplate capacity and SRP operational requirements. SRP shall own, operate, maintain, repair, control, alter, replace, and upgrade the RTU.

Facility space for the RTU is required. This location should be reasonably close to the origin of telemetering signals or data concentrator. A control room or relay house is acceptable if the temperature range is within 0°C to 70°C. The HVAC requirements for fiber optic terminal equipment are more stringent than what is required for RTU equipment. The below outlines required specifications for the RTU:

a) Cable access can be either through the top or bottom of the RTU cabinet or enclosure.

b) Floor space for standard eight-foot-tall, 19" free-standing rack.

c) A 120 VAC 15 amp convenience power source to the RTU cabinet, with backup independent redundancy. This source shall utilize a dedicated breaker labeled "SRP-RTU". A four-foot coil is to be left at the RTU location and shall be terminated by SRP inside the RTU cabinet.

d) Station DC power 10 A @ 48 VDC or 5 A @ 125 VDC (not shared with other equipment) run to the RTU cabinet for RTU power. The circuit breaker shall be labeled "SRP-RTU". If DC power is not available, a 120 VAC circuit may be used if this circuit is sourced from an uninterruptible power system with a minimum of eight-hour backup.

e) One stranded AWG #8 conductor shall be connected to station ground and run to the RTU cabinet by the Customer.

f) The Customer shall run all data signal cables for physical I/O points to the RTU cabinet or to a nearby (6 feet or less) interface cabinet for termination. Data cables must be shielded with shield grounded at RTU end only. Twisted-pair stranded wire between AWG#16 and AWG#22 or twisted-pair solid wire between AWG#18 and AWG#24 may be used. Cables containing 6, 12, 25 and 32 pairs are typical. A 10-foot coil is to be left at the RTU location and shall be terminated by SRP inside the RTU cabinet.

g) All analog quantities will be represented by a + / – 1 milliamp or a 4 to 20 milliamp current loop. The current loop may be shared if there are no grounds and it is not

driven beyond the manufacturer's specified limits. Physical status points will be presented by a dry contact available at the interface cabinet. All status points shallutilize the normally open contacts of the Customer-provided isolation relay. The RTU shall provide the contact wetting voltage.

h) The Customer shall provide data points through communication cables from an Intelligent Electronic Device (IED) directly to the RTU cabinet for termination. Typical data communication cables include standard CATV (Ethernet) cables, industrial Ethernet cable, or industrial RS-485 cables and to be discussed during project initation

i) Communication between the Customer data concentrator and the SRP RTU shall be DNP3 protocol. Other data communication protocols shall be evaluated on a case-by-case basis.

7.2. Telemetering Data

SRP uses a range of communications and sensor technologies to cover the whole service territory. The location of an interconnection can change the solution that SRP will use for communications. The earlier a one line or engineering sketch can be discussed with SRP, the sooner SRP can design a solution and assist with determining what is needed. Several factors can influence the telemetry solution and the instrumentation needed:

a) Size of the interconnected generation

b) The location in SRPs service territory

c) The load at the site of the interconnection

d) The complexity of connection to the grid (and potentially the complexity of the Customer's system behind the meter from the grid)

e) Existing communications and metering infrastructure at the site

Because of this, even two identical sites at different locations will likely end up with different configurations of metering, sensors, and communications technology.

SRP uses a combination of installed fiber optics, microwave, fixed line telephone and cellular services to cover the whole service territory. Depending on location and size, one of these will be used to communicate with the Customer's site.

SRP is able to provide all the instrumentation and sensing with the revenue meter, but if the site needs more sensing than a single meter can provide, the right current and potential transformers (Ct and Pt) need to be specified and their locations need to be determined.

Depending on the manufacture, make and model of the inverter, as well as the number of inverters, some or all of the information needed may come directly from the inverter. SRP predominately uses a communications protocol called DNPv3, which if available from your inverter directly may make communications easier to setup. Currently, the standard for inverters is the latest version of IEEE 1547 and the test standard is the latest version of IEEE 1547.1 and associated safety certification requirements listed in the latest version of UL – 1741 / UL – 1741 SA.

Example requirements for telemetry – not revenue metering, but SCADA and operations are:

7.2.1. Gross generator output (MW/Mvar)

a) Accuracy of the sensors:

i. 1% accuracy is preferred (matches what SRP uses for Automate Generation Control)

ii. 3% accuracy is acceptable (state estimation/power flow accuracy)

NOTE: Revenue quality measurement is done in accordance with ANSI C12.20.

b) Update frequency for data

i. Not faster than every 2 seconds and not slower than every 30 seconds is preferred

ii. In some cases, up to a 5-minute interval is acceptable, but not preferred.

c) Latency for data arriving at the operation center

i. Ideally not more than 1 second between the actual measurement and the arrival of the information in the control center. Latency should be measurable and consistent.

d) Batteries

i. Batteries for communication and sensors are required

ii. Batteries should be able to keep communications operational for 12 hours minimum

iii. Batteries should have status information available via communications

iv. Battery aging should be reported via communications and any change indicators alarm should be reported.

These requirements may vary by the size and location of the interconnection. These are examples only and working with SRP will refine the requirements for a specific interconnection.

It is important to contact SRP early in the process if your site is larger than 999 kW in size or has a multiple connections into SRP's grid, or has multiple large inverters (greater than 20 kW).

Additional points may be required at SRP's discretion.

7.3. Disturbance Monitoring

7.3.1. SRP shall monitor DER system sizes 1 MW and above, which is evaluated on a per project basis, the RTU shall be equipped with a "sequence of events" recorder. The Customer shall provide, wired to a terminal block near the RTU panel, enough connections to separately monitor the following:

a) An output contact of an instantaneous relay to act as a ground fault detector for faults on the utility electric system. This relay shall be connected into the same sensing source as the ground fault protective relay required by the Utility.

b) Every trip of an interconnection isolation device, which is initiated by any of the generator interconnection relaying schemes required by the utility.

c) Every trip of an interconnection isolation device, which is initiated by any of the protective systems for the generator.

d) Every trip or opening of an interconnecting isolation device, which is initiated by any other manual or electrical means.

e) A contact indicating the position of the project's primary-side main breaker.

f) A contact indicating operation of the over/undervoltage relays.

g) A contact indicating operation of the under/over-frequency relay or the utility's ground fault relay.

h) A contact indicating operation of the project-provided transformer bank relaying.

i) A contact indicating operation of any of the (51 V) relaying.

j) A contact indicating the position of the high-side fault-clearing device.

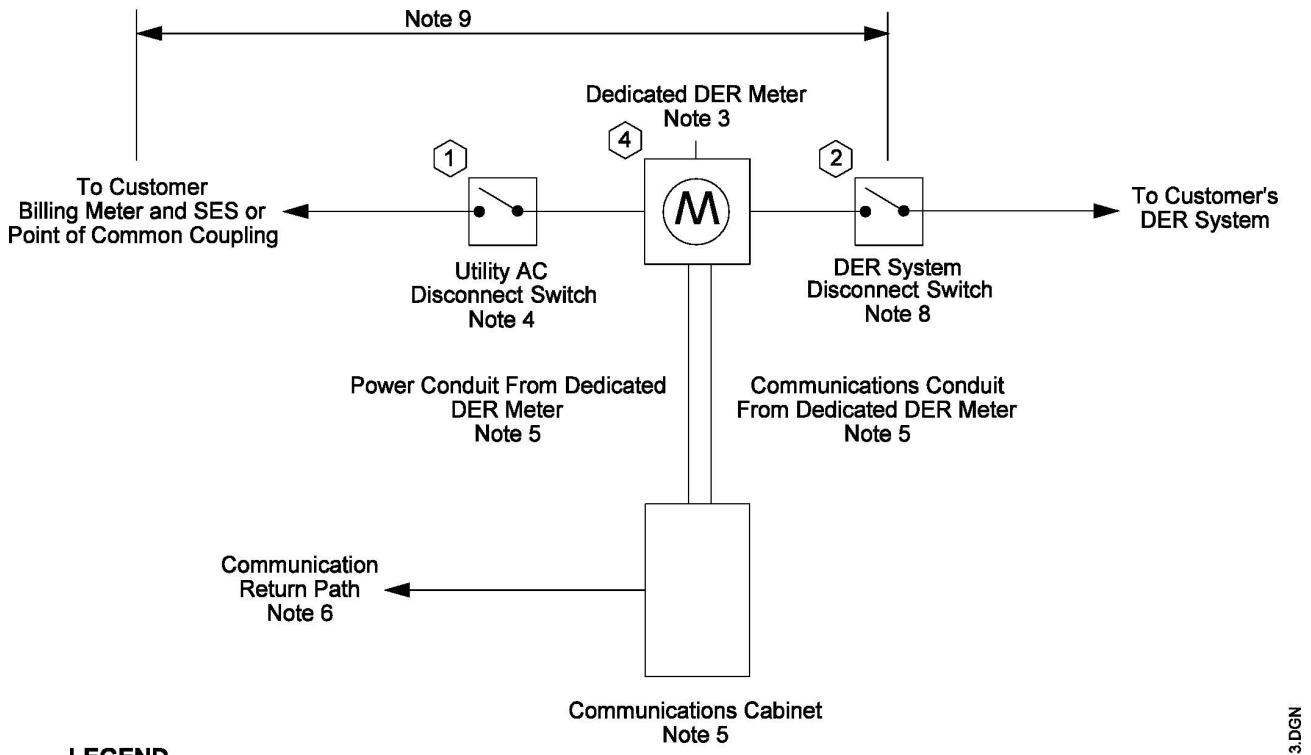
k) A contact indicating the position of the reverse power relay, if said relay is required by the utility.

7.3.2. If any of the functions indicated in items 2-4, 6, 7, 9, or 11 are combined into a multi-functional device, either:

a) Each of those functions shall be monitored independently on the RTU, or

b) Provisions acceptable to SRP shall be provided to interrogate the multi-functional device such that the operation of the individual functions may be evaluated separately. Telemetry, when required, shall be provided by SRP at the Customer's expense. In addition to other telemetry costs, a one-time charge will be assessed to the Customer for equipment and software installed at the utility's System Control Center to process the data signals.

7.4. Customer-Owned Inverter-Based Interconnection with Telemetry



LEGEND

⬡ See DER Signage, Section 2 - 6.6 for description of label callout within this Handbook.

NOTES

1. The interconnection telemetry requirements shall apply for all Customer-owned inverter-based DER systems rated 1 MW and above, or those interconnected to a dedicated industrial substation that do not have provisions to prevent back feed.
2. All Customer equipment shall be installed, maintained, and modified by the Customer in accordance with the requirements of the local AHJ, NEC and SRP. In those areas where the AHJ does not provide a city clearance, the Customer must provide a signed Certificate-in- Lieu of Clearance following the completion of all work. See SRP's ESS for a sample of the certificate.
   A. For design drawings that do not follow SRP standards, SRP reserves the right to request in writing that the design drawings be stamped by an Electrical Professional Engineer (PE) registered in the State of Arizona. All design drawings for a DER site greater than 300 kW must be stamped by an Electrical PE registered in the State of Arizona.
3. Dedicated DER meter socket shall be four-wire wye-style located as shown.
4. The utility AC disconnect switch shall be connected between the SES/POI and DER system as shown. Utility AC disconnect switch, NEMA 3R or better, shall have visible moveable blades with provisions for locking the door closed and locking the operating handle (blades) open with an SRP

lock only. The door shall be secured with an SRP-supplied Customer access padlock (CAP) and key for Customer access. The utility disconnect switch shall also have spare dry 'a-contacts' to be utilized for indication purposes for SRP.

5. A communications cabinet shall be constructed within ten feet of the dedicated DER meter socket. Power for the cabinet shall be provided via a tap from the dedicated DER meter test switch and shall be a minimum of 1" PVC conduit, buried at a minimum depth of 24". A communication connection shall be made between the dedicated DER meter socket and the communication cabinet in a minimum 1" PVC conduit buried at a minimum depth of 24". SRP Design Inspections will determine conduit stub up locations inside of the DER meter socket enclosure.
6. A communications return path from the communications cabinet shall be required via an antenna. SRP Telecom Engineering shall determine antenna locations and requirements.
7. For interconnections to a dedicated industrial substation, the status of any locations where paralleling is possible shall be monitored, including main breakers, tie breakers and disconnect switches, as applicable. Connections for any facilities required for monitoring purposes shall be made in dedicated conduits.
8. Refer to Section 2 – 2.7: System Disconnect Switches in this Handbook.
9. The SES, utility AC disconnect switch, dedicated DER meter, and associated DER system disconnect switch shall be grouped together within a maximum distance of 30' with no obstructions (sharing a common corner of the structure within the 30' distance is allowed), and is readily accessible as required in ESS Section 5: Clearances and Section 9: Metering & SES.

   EXCEPTION: If conditions prohibit grouping the SES, utility AC disconnect switch, dedicated DER meter, and associated DER system disconnect switch per the maximum distance described above, these facilities may be remotely located with SRP and AHJ approval. The remote location must be readily accessible as required in ESS Section 5: Clearances and Section 9: Metering & SES. The SES shall have signage, including a site map, indicating the interconnected generator(s), along with the specific location of the dedicated DER meter(s) and associated disconnect switch(es), as applicable.
10. The utility AC disconnect switch, DER system disconnect switch and dedicated DER meter switchboard shall be a minimum 36" from any natural gas vent. Conduits, disconnect switches and meter sockets shall not be used as a raceway for additional facilities not associated with the electrical interconnection of the DER system. If the SES is upgraded, a new SES may require relocation. Consult SRP Design.

7.5. Equipment Requirements

This section details the requirements for equipment that must be installed at an interconnection facility. This equipment serves to provide tele-protection between the DER facility and SRP's system and to the collection of telemetry used to monitor and control SRP's electric system.

SRP requires the ability to monitor and control the electric system through collecting data through a SCADA system. This means that communications circuits shall be established with interconnection facilities, at the Customer's cost, for SRP to operate the grid reliably and safely. SCADA is generally collected through an RTU that aggregates and returns data back to SRP's electric system monitoring and control systems via a communication backhaul pathway.

The type of communication system will depend on the type of relaying scheme that is required at the interconnection facilities. For interconnection facilities that require a Direct Transfer Trip (DTT) scheme or other tele-protection relaying schemes, a fiber optic communication channel from the facility to the SRP interconnection point is necessary. The fiber optic pathway can also be utilized to pass back telemetry collected by the RTU. For other facilities that require communication to an RTU, an unlicensed radio system, cellular system, or leased circuit may be required.

7.6. Physical Communication Circuit Requirements

The type of communications equipment will depend on the classification of the interconnection facility. The requirements for each facility are listed below and the type of communication depends on what type of telemetry and high-speed relaying is required.

7.7. Space Requirements

To support the collection of telemetering data, revenue metering data, and tele-protection, the Customer shall provide space at its facility to accommodate this equipment. SRP shall design, operate, and maintain certain telecommunications terminal equipment at the interconnection facility to support the operation of this equipment. This space shall be clearly designated on the Customer-provided site plan.

7.8. Power & Grounding Requirements

The Customer shall provide a connection point to the interconnection facility station ground within ten feet of the SRP communication equipment enclosure. SRP shall provide and install cabling from the equipment racks to the designated station ground termination to protect the communications equipment and service personnel.

The Customer shall provide two dedicated branch circuits that are 10 A in size when sourced from a 125 VDC system or 20 A in size when sourced from a 48 VDC system to each SRP communication enclosure. The 125 VDC or 48 VDC shall have sufficient capacity to provide 8 hours of backup to the telecommunication system, and meet IEEE 485 standards for stationary battery systems that are used to provide backup power to substation and communications equipment. The dedicated source breakers shall be labeled "XX-A" and "XX-B." If a DC power is not available, two 15-amp 120 VAC circuits may be used if the circuits are sourced from an Uninterruptible Power System (UPS) with a minimum of an 8-hour backup. The power source shall not be shared with other equipment.

Additionally, the Customer shall provide a 120 VAC 15-amp power source adjacent to the telecommunications equipment racks. This source shall be utilized for tools and test equipment by installation and maintenance personnel. A UPS is not required for this circuit. The Customer shall provide ample lighting for the safety of installation and maintenance personnel.

Grounding requirements for communication equipment shall comply with IEEE 487 standards. Each communication rack shall be grounded to the station ground and all communication equipment shall be bonded and grounded to a ground bar in the rack.

7.8.1. While SRP may discuss telecommunication connection preferences of the Customer, ultimately, SRP shall determine the selection of telecommunication connection equipment. The telecommunication connection equipment shall fit within the operating requirements, design parameters, and communications network architecture of SRP's telecommunications network.

7.8.2. Customers may share fiber optic cables for their gen-tie line protection provided each interconnection facility abides by the provisions in this Handbook.

7.8.3. Use of SRP's telecommunications infrastructure by the interconnection facility is not an option.

7.8.4. Leased data circuits, radios using unlicensed frequencies, cellular, and satellite are not acceptable options at SRP for high-speed relays supporting transmissions lines.

7.8.5. SRP's telecommunications terminal equipment, being electronic devices, shall be periodically refreshed (i.e., replaced, sometime after installation). The time until refresh depends on several factors, including its operating environment, repair history, and manufacturer support. A refresh typically occurs around 10 years but could be as early as 5 years or as long as 15 years after installation. The interconnection Customer must anticipate for these refreshes to be considered Capital Additions under the terms of the Interconnection Agreement, with the associated cost being the responsibility of the Interconnection Customer.

7.8.6. The Customer shall provide access for SRP employees and approved contractors for planned maintenance and service restoration 24 hours a day, 7 days a week after the communication equipment is installed and in operation.

8. **Pre-approved DER Meter Bases & SES Panels**

8.1. DER Meter Bases

8.1.1. Below is a list of Pre-approved meter bases used for the installation of the DER production meter, otherwise known as the DER Meter.

8.1.2. For non-pre-approved meter bases, refer to the SHOPDRAW instructions listed in Section 0 – 4.2 in this Handbook.

8.1.3. For DER applications that require test blocks, please see ESS Section 9: Self-contained Meter Sockets for more information.

Eaton Cutler-Hammer

Catalog Number	Description	Application
UNRRS101BEUSE	125 A, 600 V, 1Ø, 3-Wire, 22 kA	OH
UNRRS111BEUSE	125 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
URTRS101BE	125 A, 600 V, 1Ø, 3-Wire, 22 kA	OH
B-Line 011 SRP	125 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
B-Line 011 SRP MS18	125 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
B-Line 011 MS25	125 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
CH114TB	125 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
CH115TB	125 A, 600 V, 3Ø, 3-Wire, 22 kA	OH/UG
CH117TB	125 A, 600 V, 3Ø, 4-Wire, 22 kA	OH/UG
UNRRS202BEUSCH	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH
UNRRS213AEUSE	200 A, 600 V, 1Ø, 3-Wire, 22 kA	UG
UNRRS213BEUSE	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH
UNRRS213CEUSE	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
URTRS202BCH	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
URTRS202NEUSCH	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH
URTRS213BE	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH
URTRS213NEUSCH	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
CH124TB	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
CH125TB	200 A, 600 V, 3Ø, 3-Wire, 22 kA	OH/UG
CH127TB	200 A, 600 V, 3Ø, 4-Wire, 22 kA	OH/UG

Milbank

Catalog Number	Description	Application
U5929-XL-INS	100 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
114TB	100 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
115TB	100 A, 600 V, 3Ø, 3-Wire, 22 kA	OH/UG
117TB	100 A, 600 V, 3Ø, 4-Wire, 22 kA	OH/UG
U7490-RL	125 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
U1681-RL	125 A, 600 V, 3Ø, 3-Wire, 22 kA	OH
U4015-O	200 A, 600 V, 1Ø, 3-Wire, 22 kA	UG
U4517-DL-M4	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH
U4518-O-W	200 A, 600 V, 1Ø, 3-Wire, 22 kA	UG
U4518-XL-W	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
124TB	200 A, 600 V, 1Ø, 3-Wire, 22 kA	OH/UG
U3328-RXL	200 A, 600 V, 3Ø, 3-Wire, 22 kA	OH/UG
125TB	200 A, 600 V, 3Ø, 3-Wire, 22 kA	OH/UG
127TB	200 A, 600 V, 3Ø, 4-Wire, 22 kA	OH/UG

8.2. DER Residential SES Panels (also known as Solar Ready SES Panels)

8.2.1. Below is a list of Pre-approved SES panels used in residential DER applications for the installation of SRP's billing meter and main Customer SES and load center. Please see ESS Section 9: Metering & SES, for other pre-approved SES panels.

8.2.2. For non-pre-approved SES panels, refer to the SHOPDRAW instructions listed in Section 0 – 4.2 in this Handbook.

Eaton

Catalog Number	Description	Application
MBE1224PV100BTS/TF	100 A, 120/240 V, 1Ø, 3 WIRE, 10 kA	OH/UG
MBE1224PV125BTS/TF	125 A, 120/240 V, 1Ø, 3 WIRE, 10 kA	OH/UG
CMBE3242PV200BS/BF	225 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	UG
CMBE4242PV200BS/BF	225 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	UG
MBE2040PV200BTS/TF	225 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH/UG
MBE3042PV200BS/BF	225 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	UG
MBE4040PV200BTS/TF	225 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH/UG
MBE4040PV200TS	225 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH
MBED3042PV200BS/BF	225 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	UG
CMBE4242PV200TS	225 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH
CG403242SH	320 A, 120/240 V, 1Ø, 3 WIRE, 22 kA 1" BR Space	UG
HP404040SH	320 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	UG
HP40SH	320 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	UG

Siemens

Catalog Number	Description	Application
MC0816S1200SCT	200 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH/UG
MC2442S1200FC/SC	200 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH/UG
MC3040S1200SC	200 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH/UG
MC4040S1200SC	200 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH/UG
MC3042S1400SC	400 A, 320CL, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH/UG
MC3042S1400SD	400 A, 320CL, 120/240 V, 1Ø, 3 WIRE, 22 kA	UG

Schneider Electric

Catalog Number	Description	Application
CC18X18M200PCY	200 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH/UG
CC18X18M200PCZ	200 A, 120/240 V, 1Ø, 3 WIRE, 22 kA	OH/UG

SECTION 3: GLOSSARY

The following terms, when used herein, shall have the meaning specified.

1. **American National Standards Institute (ANSI):** Organization dedicated to supporting the U.S. voluntary standards and conformity assessment system and strengthening its impact, both domestically and internationally. See www.ansi.org.
2. **Ancillary Services**: DER output which has potential to support the grid.
3. **Authority Having Jurisdiction (AHJ):** Governmental agencies and municipalities having responsibility for public safety.
4. **Backfeed:** To energize a section of a utility electric system from a source other than its normal source.
5. **Battery Energy Storage System (BESS):** A system that captures and stores energy produced at one time to be used later using battery technology.
6. **Bulk Electric System (BES):** Greater electric network consisting of transmission level elements operating at 100 kV or higher, not including facilities used in the local distribution of electric energy.
7. **Clearance Point:** The physical location on a section of a power line or equipment that is to be visibly disconnected from all known sources of power.
8. **Cogeneration Facility:** Any facility that sequentially produces electricity, steam, or forms of useful energy (e.g., heat) from the same fuel source and is used for industrial, commercial, heating, or cooling purposes.
9. **Customer:** Any person utilizing services from SRP**.** Anyone connected to the SRP electric system that installs, owns or operates a Distributed Energy Resource.
10. **Disconnect Switch:** A visible open disconnect device that the Customer may be required to install and maintain in accordance with the requirements set forth in this document. It will completely isolate the Customer's DER from the Utility grid.
11. **Dispatchable** (by utility): A Microgrid can be used for ancillary services by the utility
12. **Distributed Energy Resource (DER):** A source of electric power that is not directly connected to a bulk power system. DER includes both generators and Energy Storage System (ES) technologies capable of exporting active power to the electric grid. This includes Customer's device(s) for the production and/or ES for later injection of electricity identified in the project application, and can consist of one or more generating units and/or ES devices, which usually can operate independently and be brought online or taken offline individually.
13. **Distribution System:** The infrastructure constructed, maintained, and operated by SRP to deliver electric service to retail Customers. This system consists of all voltages below 69 kV.
14. **Distribution Upgrades:** The additions, modifications, and upgrades to the distribution system at or beyond the Point of Interconnection, to facilitate interconnection of the DER and render the delivery service necessary to affect Interconnection Customer's wholesale sale of electricity in interstate commerce. Distribution upgrades do not include interconnection facilities.
15. **Electric Power System (EPS):** Facilities that deliver electric power to a load.
16. **Electric Service Specifications (ESS):** An SRP manual intended as a guide for making electrical installations or modifications, while protecting the interests of the Customer and complying with

regulations, which experience has shown, are necessary for safe, adequate and satisfactory service. These standards are also available online at https://www.srpnet.com/doing-business/builders-developers-contractors/commercial-specifications-guidelines-handbooks.

17. **Energy Storage System (ES):** A system that captures and stores the energy produced at one time for use later.
18. **Electric Supply/Purchase Agreement:** An agreement signed between SRP and the Customer covering the terms and conditions under which electrical power is supplied to, or purchased from, SRP.
19. **Fault Current:** The level of current that can flow if a short circuit is applied to a voltage source.
20. **Fast Transition:** A switch that parallels the generator with the utility for less than 100 milliseconds, when transferring the load to or from the utility source.
21. **Feasibility Study:** An optional study consisting of sensitivity analysis and high-level cost estimates for DER interconnection.
22. **Facilities Study:** A study conducted by SRP, or its agent, for Interconnection Customers to determine a list of facilities (including Interconnection Customer's interconnection facilities, transmission owner's interconnection facilities, system protection facilities, and if such upgrades have been determined, network upgrades, distribution upgrades, generator upgrades, common use upgrades, and upgrades on affected systems, as identified in the Interconnection System Impact Study), the cost of those facilities, and the time required to interconnect the DERs with the Distribution System.
23. **Generating Facility:** All or part of the Customer's electrical generator(s) or inverter(s) together with all protective, safety, and associated equipment necessary to produce electric power at the Customer's facility.
24. **Good Utility Practice:** Any of the practices, methods, and acts engaged in or approved by a significant portion of the electric industry during the relevant time period, or any of the practices, methods, and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety, and expedition. Good Utility Practice is not intended to be limited to the optimum practice, method, or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted in the region.
25. **Hold Tag:** The method used as an aid in protection of equipment, whereby reclosing of a line is disabled until the system operator receives a release from the person to whom the hold was issued. As it relates to distributed generation (with the exception of inverter based resources), circuits with hold tags shall have all potential sources of backfeed removed by opening, locking and tagging the appropriate disconnect switch.
26. **Institute of Electrical and Electronic Engineers (IEEE):** Leading developer of international standards that underpin many of today's telecommunications, information technology, and power-generation products and services. See www.ieee.org.

27. **Intelligent Electronic Device (IED):** A microprocessor-based controller that can also provide telemetry for power system equipment such as protective relays, meters, and other remote terminal units (RTU).
28. **Interconnection:** The physical connection of the Customer's DER to the utility system.
29. **Interconnection Agreement:** The agreement, together with appendices, signed between SRP and the Customer covering the terms and conditions governing the interconnection and operation of the generating facility with SRP.
30. **Island:** A condition occurring when a generator and a portion of the SRP electric system separates from the remainder of the electric system and continues to operate in an energized state. When the condition is unintentional, islanding may pose a safety threat or cause equipment problems.
31. **Islandable System:** A generating facility interconnected to a bus common with the utility's system, where the generating facility is designed to serve part of the utility grid that has become or is purposefully separated from the rest of the grid.
32. **Master Microgrid Controller (MMC):** The MMC is an intelligent power control system designed to manage and automate the operation of the Microgrid system. An MMC shall have the capability to monitor, control, and obtain dynamic feedback from all the individual components that make up the microgrid.
33. **Metering:** The function related to measuring the transfer of electric power and energy.
34. **Microgrid:** A group of interconnected loads and distributed energy resources with clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid, and can connect and disconnect from the grid to enable it to operate in both grid connected or island mode
35. **Microgrid Interconnection Device (MID):** A device that allows separation of a distributed energy resources (DER) island system from the electric power system (EPS) or grid. This device may provide the function of a normal paralleling device to reconnect the DER islanded system with the Area EPS.
36. **Minimum Protective Devices, Relays, and Interconnection Requirements:** The minimum required protective relaying and/or safety devices or requirements specified in this manual are for the purpose of protecting only SRP's electric system and its other Customer facilities from damage or disruptions caused by a fault, malfunction, or improper operation of the Customer's DER. These requirements do not include relaying, or other protective, and/or safety devices as may be required by industry and/or government codes and standards, equipment manufacturing and prudent engineering design and practice to fully protect the Customer's DER; those are the sole responsibility of the Customer. These requirements may be revised from time to time.
37. **National Electrical Manufacturers Association (NEMA):** Represents nearly 325 electrical equipment and medical imaging manufacturers that make safe, reliable, and efficient products and systems serving seven major markets. See www.nema.org.
38. **National Fire Protection Association (NFPA):** The NFPA delivers information and knowledge through more than 300 consensus codes and standards, research, training, education, outreach and advocacy; and by partnering with others who share an interest in furthering our mission. See www.nfpa.org.
39. **Non-dispatchable** (by utility): Utility cannot use for ancillary services.

40. **Non-Parallel Connection Agreement:** The agreement for the non-parallel connection of the Customer's DER with SRP's electric system.
41. **Non-participating Distributed Energy Resources (DER):** Distributed energy resources that are in the DER island system but are not under control of a Master Microgrid Controller (MMC).
42. **Occupational Safety and Health Administration (OSHA):** Ensures safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education and assistance. See www.osha.gov.
43. **Parallel System**: A generating facility that is electrically interconnected to a bus common with the SRP electric system, and operates in parallel either on a momentary or a continuous basis.
44. **Point of Common Coupling (PCC)**: The point of connection between the Area EPS and the Local EPS.
45. **Point of Interconnection (POI):** The physical location where SRP's electric service conductors are connected to the Customer's service conductors to allow parallel operation of the Customer's DER with SRP's electric system.
46. **Qualified Personnel:** Professional engineers, factory trained and certified technicians, and licensed electricians with experience and knowledge in testing equipment following manufacturer testing recommendations.
47. **Radial Line:** An electrical distribution line that originates from a substation and is normally not connected to another substation or another circuit sharing the common supply of electric power.
48. **Readily Accessible:** Capable of being reached directly, without obstruction at any time. For additional information, see ESS Section 5: Clearances and ESS Section 9: Metering & SES.
49. **Reclosing:** The act of automatically re-energizing a line in an attempt to restore power.
50. **Relay:** An electric device that is designed to interpret input conditions in a prescribed manner and after specified conditions are met to respond to cause contact operation or similar abrupt change in associated electric control circuits.
51. **Restricted Access Switch (RAS):** Switch, installed on an electronically controlled gate, that grants SRP access to equipment 24 hours a day 7 days a week to areas restricted by the Customer.
52. **Right-of-Way (ROW):** The right to build and operate a utility on land belonging to another.
53. **Salt River Project (SRP):** Agricultural Improvement and Power District.
54. **Separate System:** The operation of a generating facility that has no possibility of operating in parallel with SRP's electric system. Also known as a non-parallel, emergency, or stand-by generation system.
55. **Service Entrance Section (SES):** The Customer-owned main electrical panel or equipment located at its premises to which the Utility delivers electric energy via a service drop or service lateral.
56. **Site:** May encompass one or more buildings; or one or more address located within the property lines at the location of the DER facility.
57. **Small Power Production Facility**: A facility that uses primarily biomass, waste or renewable resources, including wind, solar, and water to produce electric power.

58. **System Impact Study:** An engineering study that evaluates the impact of the proposed interconnection on the safety and reliability of SRP's distribution system and, if applicable, an affected system. The study identifies and details the system impacts that would result if the DER were interconnected without project modifications, or system modifications, or to study potential impacts, including but not limited to those identified in a scoping meeting and described in SRP's Distributed Generation Interconnection Handbook.
59. **Transfer Switch:** An automatic or manual device for transferring one or more load conductor connections from one power source to another.
60. **Transfer Trip Scheme:** A form of remote trip in which a communication channel is used to transmit a trip signal from the relay location to a remote location.
61. **Transmission System:** Utility-owned high-voltage lines (69 kV or higher) and associated equipment for the movement or transfer of electric energy between power plants and the distribution system.
62. **Underwriters Laboratories Inc. (UL):** An independent laboratory facility for testing all types of electrical equipment. See www.ul.com.
63. **Utility:** The electric utility entity (SRP) that constructs, operates, and maintains the electrical distribution system for the receipt and/or delivery of power. Also referred to as the Utility Distribution Company (UDC).
64. **Utility Grade Protection Devices:** Relays specifically designed to protect and control electric power apparatus, tested in accordance with the following ANSI/IEEE standards (Latest edition unless otherwise indicated):
    a) ANSI/IEEE C37.90 – IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
    b) ANSI/IEEE C37.90.1 – IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.
    c) ANSI/IEEE C37.90.2 – IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
    d) ANSI/IEEE C37.90.3 - IEEE Standard Electrostatic Discharge Tests for Protective Relays.