

Engineering Requirements

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2. Purpose

The purpose of this document is to present the Utility’s planning and design requirements for generators connected to and operating in parallel with the Electric Systems to ensure the safety of people and property and the integrity of the Electric System.

This document is applicable to those individual generators located at a single electrical location with an aggregate nameplate capacity less than 10 MW.

3. Definitions

- 3.1. The Utility: NV Energy (NVE).
- 3.2. System User: Any customer connected to the Transmission or Distribution System.
- 3.3. Electric System: The combined Distribution and Transmission System of the Utility and all connected loads and generation sources.
- 3.4. Distribution System: Those electric facilities owned, controlled, and operated by the Utility that are not classified as part of the transmission system by the Federal Energy Regulatory Commission and subject to Utility’s open access transmission tariff (OATT) on file with the FERC.
- 3.5. Transmission System: Those facilities that are owned, controlled, and operated by the Utility that are classified as part of the transmission function in the Utility’s open access transmission tariff (OATT) on file with the FERC.
- 3.6. Parallel Generator: A generator that is interconnected to and operates in parallel with the Electric System.
- 3.7. Interconnection Study: The Interconnection Study examines steady state effects caused by parallel generators on the Utility Electric System.
- 3.8. Network Studies: The Network Study is performed using computer programs to determine the nature of any system impacts and to identify the corrective actions necessary to minimize these effects.
- 3.9. Parallel Operation: The operation of a system in which generation can be connected to a bus common with the Electric System such that power transfer between the Parallel Generator’s facilities and the Distribution System may result.
- 3.10. Capacity: The nameplate rating or aggregate total of the nameplate ratings of all of the units at one location.
- 3.11. WECC: Western Electric Coordinating Council

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4. Disclaimers

The standards outlined in Section 8.0 herein are for the protection of the Utility and System Users and are not for the protection of the Parallel Generator. The Utility's recommendations for Parallel Generator protection are included in Section 9.0. Such recommendations are not intended to be a comprehensive and exhaustive list of relays or equipment required to protect the Parallel Generator. The Parallel Generator is responsible for the protection of the generator and associated equipment.

5. Interconnection and Network Study Requirements

An Interconnection Study, (See Attachments 2 & 3 for required data) which develops requirements and alternatives with supporting cost estimates for the required interconnection facilities, will be required when the Utility determines that the addition of the proposed Parallel Generation has the potential to cause the circuit to operate outside normal operating parameters. In addition a Network Study may also be required when the Utility believes that the size and location of the proposed generation has the potential to result in system conditions that might adversely impact the system during transient conditions. The customer must submit additional technical data if a Network Study (see attachments 2 & 3) must be conducted. The Utility will coordinate all necessary studies.

5.1 Interconnection Study

The Interconnection Study examines steady effects caused by the Parallel Generators on the Electric System. The study is computer based and models the Parallel Generation within the Electric System. The Study will determine the optimum interconnection alternative for the project and recommend a system that meets the Utility's reliability and quality of service standards.

5.2 Network Study

Network Studies are normally only required for specific applications of Parallel Generators over 5 MW. When justified by potential operating problems, which maybe caused by generation being added to the Electric System, Network Studies may be required. The Network Study is performed using a computer program to determine the nature of any system impacts and to identify the corrective actions necessary to minimize their affects, thereby assuring compliance with all WECC and the Utility reliability standards. Depending on the size of the Parallel Generator, the Network Studies may require internal the Utility review and possibly review by a WECC Study Group. All Network Studies are required to meet this WECC and the Utility Assessment Practices Document. The need for a Network Study will be determined by preliminary analysis of the Interconnection Study. The following factors influence the need for a Network Study.

- Size of the Parallel Generator.
- Location of the Parallel Generator with respect to the other generators or System User's loads.
- Probability of islanding the Parallel Generator with other loads.
- Electrical Strength of the interconnected Electric System.
- Connection to the EHV (230kV and above) system.
- Location and use of series capacitors-SSR

6. Metering Arrangements

Metering installations shall comply with the Utility's Electric Services and Metering Requirements.

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7. Interconnection Agreement, Application Forms and Data Forms

The Parallel Generator must execute an interconnection agreement with the Utility prior to the interconnection and operation of the Parallel Generator.

8. Utility Design Requirements: Parallel Generator

The requirements include equipment standards, design standards, and some operating standards. The requirements are broken into two groups. The two groups are; Net Metering Systems (RE03) and all other Parallel Generators up to 10 MW.

8.1 Net Metering Systems

Refer to the Utility's Net Metering System Design and Operating Procedures, RE03, for requirements.

8.2 All Other Parallel Generators

8.2.1. Parallel Generators with a capacity of 10 MW or less (not including Net Metering Systems) shall meet all of the requirements of:

- A. The National Electric Code,
- B. Underwriters laboratories Inc.
- C. Institute of Electrical and Electronic Engineers with IEEE Standard 1547 having particular application (The optional visible and lockable disconnects of IEEE 1547 are required).
- D. National Electric Safety Code

8.2.2. In addition Parallel Generators with a capacity of 10MW or less (Not including Net Metering Systems) shall comply with the following:

8.2.2.1. Protective Functions shall be equipped with automatic means to prevent reconnection of the Generating Facility with the Distribution System unless the electric System service voltage and frequency is of specified settings and has been stable for a minimum of five minutes.

8.2.2.2. Circuit breakers or other interrupting devices at the Point of Delivery must be Certified or "Listed" (as defined in Article 100, the Definitions Section of the National Electrical Code) as suitable for the application. This includes being capable of interrupting maximum available fault current. For Parallel Generators with a capacity of one MVA or greater or where total generation capacity on a line segment is greater than 50% of the minimum load on that line segment, the Parallel generator shall be designed so that the failure of any one device shall not potentially compromise the safety and reliability of the Electric System. A line segment is a portion of a line that can be automatically isolated to create an island by the Utility's protective devices.

8.2.2.3. Power Factor: Parallel Generators with a capacity of less than 11kva shall operate at a power factor > 0.85 (lagging or leading) when output is >10% of rating. All other generating Units compromising a Parallel Generator shall be capable of and operate at some point within a range of a power factor of 0.95 (either leading or lagging). Operation outside this range is acceptable provided the reactive power of the Parallel Generator is used to meet the reactive power needs of on-site loads or that reactive power is otherwise provided under tariff by the Utility. The Parallel Generator shall notify the Utility if it is using the Parallel Generator for power factor correction.

8.2.2.4. Limits specific to single-phase generators. For single-phase generators connected to a shared single-phase secondary system, the maximum capacity shall be 20kva. Parallel Generators applied on a center-tap neutral 240-volt service must be installed such that no more than 6kva of imbalance in capacity exists between the two sides of the 240-volt

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service. For dedicated distribution transformer services, the limit of a single-phase Parallel Generator shall be the transformer nameplate rating.

- 8.2.2.5. Three-phase synchronous generators: Parallel Generator circuit breakers shall be three-phase devices with electronic or electromechanical control. The Parallel Generator shall be responsible for properly synchronizing its Parallel Generator with the Utility's Electric System by means of either a manual or automatic synchronizing function. Automatic synchronizing is required for all synchronous generators, which have a Short Circuit Contribution Ratio (SCCR) exceeding 0.05. A Parallel Generator whose SCCR exceeds 0.05 shall be equipped with protective functions suitable for detecting loss of synchronism and rapidly disconnecting the Parallel Generator from the Electric System. The Short Circuit Contribution Ratio is the ratio of the Parallel Generator's short circuit contribution to the Utility's short circuit contribution for a three-phase fault at the high voltage side of the transformer connecting the Parallel Generator to the Utility's system.
- 8.2.2.6. Unless otherwise agreed to between the Parallel Generator and the Utility, synchronous generators shall automatically regulate power factor, not voltage, while operating in parallel with the Electric System. Power system stabilization is specifically not required for Parallel Generators with Capacity under 10MW.
- 8.2.2.7. Induction Generators. Induction Generators do not require separate synchronizing equipment. Starting or rapid load functions on induction generators can adversely impact the Utility's Electric System's voltage. Corrective step-switched capacitors or other techniques may be necessary and may cause undesirable Ferro resonance. When these counter measures (e.g. additional capacitors) are installed on the Parallel Generator's side of the Point of Delivery, the Utility must review these measures. Additional equipment may be required to resolve this problem as a result of an Interconnection Study.
- 8.2.2.8. Inverter Systems. Utility-interactive inverters do not require separate synchronizing equipment. Non-Utility-interactive stand-alone inverters shall not be used for parallel operation with the Utility's Electric System.
- 8.2.2.9. Telemetry. If the nameplate rating of the Parallel Generator is 1 MW or greater, telemetry equipment may be required at the Parallel Generator's expense. If the Parallel Generator is interconnected to a Distribution System operating at a voltage below 10kV (Line-to-Line), then telemetry equipment may be required on Parallel Generators 250 kW or greater. The Utility shall only require telemetry to the extent that less intrusive and/or more cost effective options for providing the necessary data in real time are not available. The minimum information which will be remotely monitored with the telemetry equipment are listed as follows:
- Watts in/out
 - Vars in/out
 - Amps
 - KWhr and kVARhr
 - Line voltage at interconnection
 - Interconnection breaker status/control
 - Phase angle across the interconnection power circuit breaker
 - The Utility may require any or all of the tests provided in the body and Annexes to IEEE 1547
- 8.2.2.10. Reclose Block. If the capacity of the connected parallel generation is greater than 1/3 of the minimum load of the distribution feeder, then reclose block for the energized distribution feeder will have to be installed on the Utility substation feeder breakers and

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backup feeder breakers that will be used to connect the generation to the Utility distribution and transmission system. Reclose block may not be required if an engineering study by a qualified electrical engineering consultant with extensive experience in completing Distribution Generation Interconnection Studies determines it is not necessary.

8.2.2.11. Instrument Transformers. Current transformers serving the interconnection relays shall be class C400 or better. Voltage transformer shall have an accuracy class of 1.2 and a VA rating adequate to carry the load on the circuit and stay within the accuracy class. Instrument transformers for the metering circuits will have separate requirements.

8.2.2.12. Additional requirements may apply where the Parallel Generator connects to a system on which the normal operating voltage is greater than 25kV.

8.3 Interconnecting Line Extension

8.3.1. If the Parallel Generator is connected to the Distribution System the design, procurement and construction of the interconnection line extension of the Parallel Generator shall be done in accordance with Rule 9.

8.3.2. If the Parallel Generator is connected to the Transmission System, the Utility will direct the design, procurement, and construction of any interconnection line extension.

8.3.3. All interconnecting transmission or distribution lines must be constructed in compliance with the Utility's applicable design, construction, and material standards. In addition, all rights-of-way and permits will be reviewed and accepted by the Utility. It is the responsibility of the Parallel Generator to obtain all necessary rights-of-way and permits.

8.3.4. The extension line (transmission or distribution) design will be submitted to the Utility for review to ensure that the proposed installation meets the minimum requirements as specified by the Utility. The minimum standards include, but are not limited to, the Utility's Transmission Line Standards, the Utility's Distribution Line Standards, and WECC Rules.

9. Protection Design Recommendations: Parallel Generator

The Parallel Generator is responsible for protection of its facilities from any and all sources of potential damage. The minimum design requirements in Section 8.0 are not intended to protect the Parallel Generator from every possible source of damage. It is recommended that the Parallel Generator utilize a Professional Engineer with Registration in the state where the Parallel Generator is located to appropriately specify, apply and integrate the Parallel Generator into the Electric System.

- Over/under-speed protection (IEEE 12/14)
- Phase and/or ground distance (IEEE 21)
- Reverse power protection (IEEE 32)
- Loss of excitation protection (IEEE 40)
- Loss of Phase/negative sequence protection (IEEE 46)
- Over current protection (IEEE 50/51)
- Machine ground protection (IEEE 64)
- Generator differential protection (IEEE 87G)
- Transformer difference protection (IEEE 87T)

Multifunction microprocessor relays having functions appropriate for the application can often perform a number of these functions. In critical applications relays are recommended.

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Further guidance for the protection of generators can be found in publications such as IEEE/ANSI C37 series guide recommendations and IEEE publication catalog number 95TP 102.

10. Attachments

Attachment 1: Parallel Generator Interconnection Application for Installations up to 200kW

Attachment 2: Parallel Generator Interconnection Application for Installations with a Capacity of 201kW to 10,000kW

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Attachment 1

Parallel Generator Interconnection Application for Installations Up to 200kW

Facility Information		Where will the Generating Facility be Installed?		
Contact Person	Phone	Fax	Email Address	
Company Name		Meter Number		
Street Address	City	State	Zip Code	
Mailing Address (if different from street address)	City	State	Zip Code	

Applicant Information		Who will be contractually obligated for this Generating Facility?		
Contact Person	Phone	Fax	Email Address	
Company Name		Meter Number		
Street Address	City	State	Zip Code	
Mailing Address (if different from street address)	City	State	Zip Code	

Contractor/Installer Information		(if different from above)		
Contact Person	Phone	Fax	Email Address	
Company Name		Meter Number		
Street Address	City	State	Zip Code	
Mailing Address (if different from street address)	City	State	Zip Code	

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Attachment 1: Installation Questions

1. How many Generators do you intend to install behind the single meter covered by this application for this Generating Facility? _____ (Number of Generators)

Note: Multiple Generators connected through a single interface and controlled as one generating set count as one Generating Facility. Example: photovoltaic panels connected through a single inverter or multiple micro-turbines connected through a single interface and controlled as one generating set count as one Generating Facility. If you plan to use more than one type of Generator, please provide the information for each type and specify how many of each type you plan to use.

2. Do you plan to export to the Distribution System? Yes No

If **Yes**, continue to Question 2.1.

If **No**, Continue to Question 3.

- 2.1. Is the Generating Facility a Qualifying Facility (QF)? Yes No

- 2.2. What is the estimated net annual export in kWh? _____ (Net Export kWh)

3. What mode of operation do you plan?

As Available	<input type="checkbox"/>	Prime Power (Base Load)	<input type="checkbox"/>
Demand Management	<input type="checkbox"/>	Peak Shaving	<input type="checkbox"/>
Combined Heat and Power	<input type="checkbox"/>	Load Following	<input type="checkbox"/>
Other (Describe):			

4. Do any of your generating units start by using grid power (motoring)? Yes No

If **Yes**, continue to Question 4.1.

If **No**, Continue to Question 5.

- a. What is your inrush current? _____ (Inrush Current)

- b. What is the continuous ampere rating of your service entrance equipment? ____ (Ampere Rating)

5. Is the Gross Nameplate Rating of your Generating Facility system 10kVA or less? Yes No

If **Yes**, skip to Question 7

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6. Short Circuit Current Capability:

6.1. What is the short circuit current capability of the Generating Facility at the Generating Facility's terminals? _____ (Amps) _____ (Nominal Voltage)

6.2. If you intend to have only one generating set behind the single meter covered by this application, skip to Question 14.3.

6.3. During a distribution system fault, what is your short circuit contribution? _____ (Amps)

Note: To answer this question, you may need to gather the following from the Generator manufacturer:

1. Fault duration curve and fault current interrupt time of the interrupting device, or:
2. Synchronous machines only, the greater of:
 - a. Fault Current interrupt time of the interrupting device; including the:
 - Direct axis synchronous reactance (X_d),
 - Direct axis transient reactance ($X'd$), and
 - Direct axis subtransient reactance ($X''d$), or:
 - b. The inertia constant of prime mover or Generator, including the:
 - Direct axis synchronous reactance (X_d),
 - Direct axis transient reactance ($X'd$), and
 - Direct axis subtransient reactance ($X''d$).

7. Will you install a Dedicated Transformer in connection with the installation of your proposed Generating Facility? Yes No

If **Yes**, continue to Question 7.1.

If **No**, Continue to Question 8.

11.1. If you are adding a transformer, please provide the following:
 _____ (Rating KVA) _____ (Primary Volts) _____ (Secondary Volts) _____ (Impedance)

8. What is your estimated date of initial operation? _____ (Date)

9. Is the unit a pre-packaged prime mover/generator/inverter/controller system? Yes No

If **Yes**, continue to Question 9.1.

If **No**, Continue to Question 11.

9.1. Who is the manufacturer? _____ (Manufacturer Name)

9.2. What is the model number? _____ (Model Number)

10. What are the Gross and Nameplate Ratings in KVA? _____ (Gross KVA) _____ (Net KVA)

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11. Prime Mover Information:

What is the prime mover technology? Please check all of the appropriate boxes.

IC Engine	<input type="checkbox"/>	Fuel Cell	<input type="checkbox"/>	Comb. Turbine	<input type="checkbox"/>
Microturbine	<input type="checkbox"/>	Hydro	<input type="checkbox"/>	Steam Turbine	<input type="checkbox"/>
PV	<input type="checkbox"/>	Wind	<input type="checkbox"/>		
Other (Describe):					

11.1. Who is the prime mover manufacturer? _____ (Manufacturer Name)

11.2. What is the prime mover model number? _____ (Model Number)

12. Generator/Inverter Information:

Inverter	<input type="checkbox"/>	Single Phase	<input type="checkbox"/>
Induction	<input type="checkbox"/>	Three Phase	<input type="checkbox"/>
Synchronous	<input type="checkbox"/>		
Other (Describe):			

Who is the generator/inverter manufacturer? _____ (Manufacturer Name)

What is the generator/inverter model number? _____ (Model Number)

13. What is the power factor range of the generator/inverter? _____ (Min) _____ (Max)

Is the range adjustable? Yes No

Note: When paralleled with the Utility's Distribution System, the unit is required to operate in a power factor regulation mode (not in voltage regulation mode).

14. The following attachments must accompany the application when you submit it (check if included):

- Complete and accurate protection diagrams including single-line meter relay and logic diagrams.
- A description of the proposed protection schemes and description of operations.
- Maintenance plans for the interconnection protective devices and interconnection interrupting devices.
- Any other documentation and certifications that may assist The Utility in approving your generating unit for interconnection with The Utility's distribution system.

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Attachment 2

Parallel Generator Interconnection Application for Installations with a Capacity of 201kW to 10,000kW

Facility Information		Where will the Generating Facility be Installed?	
Contact Person	Phone	Fax	Email Address
Company Name		Meter Number	
Street Address	City	State	Zip Code
Mailing Address (if different from street address)	City	State	Zip Code

Applicant Information		Who will be contractually obligated for this Generating Facility?	
Contact Person	Phone	Fax	Email Address
Company Name		Meter Number	
Street Address	City	State	Zip Code
Mailing Address (if different from street address)	City	State	Zip Code

Contractor/Installer Information		(if different from above)	
Contact Person	Phone	Fax	Email Address
Company Name		Meter Number	
Street Address	City	State	Zip Code
Mailing Address (if different from street address)	City	State	Zip Code

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Attachment 3 Standard Data Required for a Generation Interconnection Study

Note: For values given in per unit, please include bases. If there are any questions concerning these forms, please contact The Utility.

*1. **A range and township site map** of the planned facilities with the turbine/generator, step/up transformer, and substation identified (please attach).

*2. **A one-line diagram** of the planned generation facilities (lease attach). The one-line diagram should include:

- A. Transmission/Distribution Line(s)
- B. Generators
- C. Transformers
- D. Motors
- E. Breakers
- F. Fuses
- G. Lightning arrestors
- H. Disconnect switchers
- I. Power factor correction equipment (i.e., capacitors/reactors)
- J. Station service loads
- K. Other special devices

*3. **A construction schedule** with construction power, start-up power, and full load testing dates identified. If a more detailed schedule is available, please attach.

Start Construction: _____ (date)

Construction Complete: _____ (date)

Start-up, Begin Full-load Testing: _____ (date)

Full-load Testing Complete _____ (date)

*4. **An estimated one-line date** and the total future capacity for any additional generation added at the initial site.

MW: _____ (date)

MW: _____ (date)

MW: _____ (date)

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5. Turbine/generation Data:

Information should be provided for each generator. Generators must be synchronous if aggregate is 1MVA or greater.

	Unit 1	Unit 2	Unit 3
A. Type of generating unit (i.e., induction or synchronous)	_____	_____	_____
Manufacturer	_____	_____	_____
Excitation system type	_____	_____	_____
B. Rated MVA	_____	_____	_____
C. Maximum Gross Output (MW)	_____	_____	_____
D. Rated leading power factor	_____	_____	_____
Rated lagging power factor	_____	_____	_____
E. Nominal voltage and acceptable voltage range (volts +/-%)	_____	_____	_____
F. Estimated load factor, number of hours/year of operation, or MWH/year.	_____	_____	_____
G. Stability Data:			
1. Inertia of turbine/generator (MW-Sec)	_____	_____	_____
2. Transient direct axis reactance (PU)	_____	_____	_____
3. Excitation system data (Note 1, Attach)	_____	_____	_____
4. Governor data (Note 1, Attach)	_____	_____	_____
5. Laplace transform block diagrams of the control equipment (Note 1, Attach)	_____	_____	_____
H. Voltage/Frequency Limits			
1. Pickup settings	_____	_____	_____
2. Roll off rates	_____	_____	_____
I. Minimum/maximum Excitation Limits			
1. Underexcitation			
a. Instantaneous	_____	_____	_____
b. Time delayed	_____	_____	_____
2. Overexcitation			
a. Instantaneous	_____	_____	_____
b. Time delayed	_____	_____	_____

Note 1: This information may not be required for an Interconnection Study, but required before the actual operation of the unit.

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6. Step Up Transformer Data:

Note: Information should be provided for each transformer. Step-up transformer(s) shall normally be grounded WYE on the high voltage winding. Other configurations on the high side winding are acceptable where the Parallel Generator's engineer can demonstrate satisfactory performance in detecting and clearing the Parallel Generator from faults on The Utility's electric system

	XFMR 1	XFMR 2	XFMR 3
A. Self-cooled and top MVA ratings (OA/FOA MVA)	_____	_____	_____
B. Nominal voltage rating (kV) available taps for each winding (+/-%)	_____	_____	_____
C. Electrical configuration of each winding			
1. High side winding	_____	_____	_____
2. Low side winding	_____	_____	_____
D. Impedance of the OA Base (%)			
1. Positive sequence	_____	_____	_____
2. Zero sequence	_____	_____	_____

7. Auxiliary Load Data:

- A. Maximum load and power factor (i.e., during plant shutdown and minimum facilities operating) _____ (kW & PF)
- B. Maximum load during start-up _____ (kVA)
- C. Maximum load and power factor during normal operation (KW & PF). Provide for one unit operating, two units operating, etc.
 - One Unit Operating _____ (kW & PF)
 - Two Units Operating _____ (kW & PF)
 - Etc.
- D. Largest motor to be started _____ (HP)
 - Starting method _____ (Starting Method))
 - Inrush KVA at rated motor voltage _____ (kVA)
 - Starts per hour _____ (Starts)

8. Conductor, spacing, and length of any distribution or transmission lines planned to be constructed by the power producer:

- A. Conductor size & type _____ (Conductor Size/Type)
- B. Spacing _____ (Feet)
- C. Length _____ (Miles)
- D. Voltage _____ (kV)

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