Technical Guidelines and Requirements for Parallel-Operated Customer-Owned Generation Interconnecting to the Electric Distribution System

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I. PURPOSE

The purpose of this guideline is to outline the technical requirements for safe and effective interconnection of distributed generation either interconnected to the Alliant Energy Corporation (Company) electric distribution system or connected to the electric facilities of Company’s electric customer.

Distributed Generation Facility (DG Facility) includes electric generators that are ultimately connected in parallel for more than 100 milliseconds, or more than six cycles, to the Company’s electric distribution system. The Company’s electric distribution system is located in Iowa and Wisconsin. It is operated at a nominal voltage of 35 kV or less. The manner in which the distributed generation is connected to and disconnected from the Company’s electric distribution system can vary.

II. INTERCONNECTION POLICY

The Company’s Interconnection Policy permits an Interconnection Customer to operate generating equipment in parallel with the Company’s electric distribution system, providing it can be done safely. The Company strives to provide a safe and reliable interconnection and to carry out the interconnection process in a timely manner.

- All services must meet all applicable requirements of the Company’s two manuals, Electric Service Equipment Manual and Electric Service Rule Book, which can be found at the following location:

- All DG Facilities will require an application and an Interconnection Agreement which can be found at the following location:
  http://www.alliantenergy.com/SellMyPower

- All DG Facilities sized to sell energy back to the Company will be required to sign a Power Purchase Agreement (PPA).

- Single-phase and three-phase customer-owned generation may be connected in parallel with the Company’s electric distribution system providing these facilities meet the requirements outlined in this guideline. The Company’s approval process shall be followed when an Interconnection Customer is interested in paralleling with the Company’s electric distribution system. The Company’s employees shall report findings of any unapproved parallel operation to Company’s System Protection and Distribution Engineering Departments. A management team will review the facilities and take any necessary action to ensure safe operation. The Company will reserve the right to open the inter-tie to any DG Facility who violates the requirements outlined in this guideline.
Technical Guidelines and Requirements

- The Company shall not assume any responsibility for the protection of the DG Facility, or any other customer’s equipment. The Interconnection Customer shall be completely responsible for protecting their system from any abnormalities.

- The Company requires that certain protective devices, as outlined in this document, shall be installed at the Point of Common Coupling (PCC), also the Point of Interconnection (POI), and is where an Interconnection Customer desires to operate their distributed generation in parallel with the Company’s electric distribution system. The purpose of the protective devices is to separate a parallel-operated DG Facility from the Company’s electric distribution system during abnormal operating conditions and when the Company’s personnel are performing maintenance on its electric distribution system. This is done to protect the general public and Company personnel from injury and to prevent damage to the Company’s equipment and the DG Facility.

- If energy production on any single circuit exceeds the circuit’s hosting capacity then the application will be required to go to a higher level of analysis for System Impact Study. The Company will determine maximum circuit threshold for each application request.

- The Company will study the generator’s nameplate capacity impact on local distribution system and retain the right to limit the size of DG based on the size of the local substation equipment. Unintentional backflow onto the transmission system may occur during low load periods throughout the year.
  - The Company will not allow the DG Facility to interconnect if the generation is to be sold to the MISO market without adhering to the MISO interconnection study process.

- The Company will approve additions based upon the correctly completed application submittal date for determining who is first for use of hosting capacity, curtailment or sizing limitations.

- The Company shall retain the right, but not the obligation, to immediately sever or disconnect with the DG Facility if, in the sole judgment of Company personnel, such action is necessary to protect the Company’s facilities, employees, or the general public, and shall not be liable for any damage which may result from the disconnection.

- The Interconnection Customer does not need an interconnection agreement if the generator does not provide the capability to operate in parallel with the Company’s electric distribution system for more than 100 milliseconds. In this instance there shall be no means, either deliberate or accidental, by which parallel operation in excess of 100 milliseconds may be achieved.

III. REGULATORY COMPLIANCE
To interconnect with the Company’s electric distribution system, the following are requirements:

- Safety of personnel and equipment has highest priority.

- Depending upon the size and location of the DG, either a review or an interconnection study is required in accordance with the state’s administrative codes. The type of review or interconnection study (“review/study”) is described within the specific state administrative code.

  - Iowa Administrative Code (IAC) Utilities 199 Chapter 45, Electric Interconnection of Distributed Generation Facilities
    

  - Wisconsin Administrative Code (WAC) Chapter Public Service Commission [PSC 119], Rules for Interconnecting Distributed Generation Facilities
    
    http://docs.legis.wisconsin.gov/code/admin_code/psc/119

- The Interconnection Customer is cognizant of and shall comply with all applicable federal, state and local codes, safety rules, regulations and practices applicable to the personnel and equipment that will be utilized in the performance of its obligations under the Standard Interconnection Agreement. For example, Iowa Administrative Code (IAC), Wisconsin Administrative Code (WAC), National Electric Code (NEC), National Electric Safety Code (NESC), and all applicable building codes.

- The Interconnection Customer is responsible for specifying appropriate equipment so that the parallel generation is compatible with the electric distribution system and meets the applicable standards within IEEE Standard 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems.

IV. INTERCONNECTION PROCESS

The interconnection process guides the Interconnection Customer and the Company’s employees through the application and approval process. The interconnection application and general overview of the DG interconnection process for Iowa and Wisconsin can be accessed via the Company’s website:

- Browse www.alliantenergy.com

- Select “About Alliant Energy” tab,

- Click on Our Environmental Commitment section,

- Click on “installing your own solar panels, small wind turbines or other generation source” under the Customer-Owned Generation header.

A. IOWA
The Iowa Administrative Code (IAC) – Utilities 199 Chapter 45, *Electric Interconnection of Distributed Generation Facilities*, depicts the level of review for the DG Facility on the basis of the aggregate nameplate capacity of 10 MVA or less.

- **Level 1** – Lab-certified inverter-based generator with a nameplate capacity rating of 10 kVA or less
- **Level 2** – Lab-certified interconnection equipment with an aggregate electric nameplate capacity rating less than or equal to 1MVA and interconnects to radial distribution or limited to serving one customer
- **Level 3** – The nameplate capacity rating is 1 MVA or less, located on a radial distribution circuit, does not export power, and is not served by a shared transformer
- **Level 4** – The nameplate capacity rating of generator is less than or equal to 10 MVA and has not qualified for a Level 1, 2, or 3 review

The Company’s interconnection process in Iowa is depicted in the following link: [https://www.alliantenergy.com/AboutAlliantEnergy/EnvironmentalCommitment/CustomerOwnedGeneration/029969](https://www.alliantenergy.com/AboutAlliantEnergy/EnvironmentalCommitment/CustomerOwnedGeneration/029969)

### B. WISCONSIN

The DG Facility with a capacity of 15 MW or less in accordance with the Wisconsin Administrative Code (WAC) – Public Service Commission, Chapter PSC 119, *Rules for Interconnecting Distributed Generation Facilities*, are reviewed depending upon their category:

- **Category 1** – DG facility of 20 kW or less
- **Category 2** – DG facility of greater than 20 kW and not more than 200 kW
- **Category 3** – DG facility of greater than 200 kW and not more than 1 MW
- **Category 4** – DG facility of greater than 1 MW and not more than 15 MW

The Company’s interconnection process in Wisconsin is depicted in the following link: [https://www.alliantenergy.com/AboutAlliantEnergy/EnvironmentalCommitment/CustomerOwnedGeneration/029971](https://www.alliantenergy.com/AboutAlliantEnergy/EnvironmentalCommitment/CustomerOwnedGeneration/029971)

### V. ELECTRICAL DISTRIBUTION SYSTEM DESIGN AND OPERATING REQUIREMENTS
The Company will operate, maintain, and own all components that are an integral (networked) part of the Company’s electric distribution system including all buses, circuit breakers, relays, and switches on the distribution side of the generator's isolating switch.

The following operating requirements apply to all interconnected generating equipment. The Company shall be the source side and the customer’s system shall be the load side in the following requirements.

The Company monitors and/or controls the electric distribution system at the following dispatch centers:

- Distribution Dispatch Center (DDC) – located in Cedar Rapids, IA and Janesville, WI
- Generation Dispatch Center (GDC) – located in Madison, WI

**A. VOLTAGE REGULATION AND CLEARING TIMES**

The Interconnection Customer shall operate their generator(s) to maintain the same voltage level as the Company’s electric distribution system at the PCC/POI and voltage regulation is required to be in service whenever the generator is synchronized to the system. Undervoltage and overvoltage functions are applied to prevent unintended islanding operation. The Interconnection Customer must provide an automatic method of disconnecting their generator(s) from the Company’s electric distribution system if the voltage cannot be maintained within the Company’s limits as stated in the following table.

**Table V.A.1 Voltage Disturbance Delay & Trip Times**

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Voltage $^{[1]}$</th>
<th>Clearing Time $^{[2]}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50%</td>
<td>&lt; 60</td>
<td>0.16</td>
</tr>
<tr>
<td>50% - 88%</td>
<td>60 - 105.6</td>
<td>2.0</td>
</tr>
<tr>
<td>88% - 110%</td>
<td>105.6 - 132</td>
<td>Normal Operating Range</td>
</tr>
<tr>
<td>110% - 120%</td>
<td>132 - 144</td>
<td>1.0</td>
</tr>
<tr>
<td>&gt; 120%</td>
<td>&gt; 144</td>
<td>0.16</td>
</tr>
</tbody>
</table>

$^{[1]}$ Voltage based on 120V nominal.

$^{[2]}$ Total Clearing Time includes breaker & relay time.

**B. VOLTAGE FLICKER**

The starting of motors and generators may cause inrush currents in excess of normal steady-state operating current. These inrush currents will cause voltage sag (flicker), which can adversely impact the operation of some electrical equipment. The DG is not allowed to produce excessive flicker to adjacent electric customers. Therefore, they shall not cause voltage fluctuations (flicker) in excess of 2% on the Company's electric distribution system at the PCC/POI.
C. FREQUENCY

The frequency of the Company’s electric distribution system shall be 60 Hz nominal and shall be maintained within the limits of 59.3 - 60.5 Hz under normal steady-state operation. Under frequency and over frequency functions are applied to prevent unintended islanding operation. The Interconnection Customer shall provide an automatic disconnecting means from the Company’s electric distribution system when generation falls outside the values prescribed in the following table.

Table V.C.1 Frequency Disturbance Delay & Trip Times

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Clearing Time [2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units ≤ 30kW</td>
<td></td>
</tr>
<tr>
<td>&lt; 59.3</td>
<td>0.16</td>
</tr>
<tr>
<td>59.3 - 60.5</td>
<td>Normal Operating Range</td>
</tr>
<tr>
<td>&gt; 60.5</td>
<td>0.16</td>
</tr>
<tr>
<td>Units &gt; 30kW</td>
<td></td>
</tr>
<tr>
<td>&lt; 57</td>
<td>0.16</td>
</tr>
<tr>
<td>57 - 59.3</td>
<td>Adjustable Delay [3]</td>
</tr>
<tr>
<td>59.3 - 60.5</td>
<td>Normal Operating Range</td>
</tr>
<tr>
<td>&gt; 60.5</td>
<td>0.16</td>
</tr>
</tbody>
</table>

[3] DG Facility breaker must open before the Company’s breaker recloses.

D. POWER FACTOR

The DG Facility shall maintain at all times a power factor range of 95% lagging (sourcing VARs to the grid) to 95% leading (absorbing VARs from the grid) while generating, measured at the PCC/POI. Failure of the DG Facility to maintain a power factor within this range may result in rate penalties to the Interconnection Customer and/or discontinuation of the parallel operation. For some generators, power factor requirements may be more or less restrictive.

E. HARMONICS


The Interconnection Customer shall cooperate with the Company during the analysis of harmonic disturbances and when necessary, provide the Company’s personnel access to generation system
equipment for testing and to obtain information relating to the causes and magnitude of the disturbances. The Company will not be responsible for any DG Facility costs associated with the harmonic analysis.

The Interconnection Customer shall comply with all Company recommendations for the installation and operation of corrective equipment required to mitigate any harmonic disturbances generated by the DG Facility. The Interconnection Customer is responsible for the cost to install and operate this equipment.

The Interconnection Customer will be required to properly maintain all harmonic correction equipment installed. If the generation produces unacceptable harmonics during parallel operation, or if this equipment fails or no longer provides the level of harmonic correction as designed per IEEE Standard 1547 (Table V.E.1) the Company shall disconnect and lock-out generator from the Company’s electric distribution system until the harmonic correction equipment is repaired and operational.

**Table V.E.1 Maximum Harmonic Current Distortion in Percent of Current (I)**

<table>
<thead>
<tr>
<th>Individual Harmonic Order (odd harmonics)$^2$</th>
<th>h&lt;11</th>
<th>11&lt;h&lt;17</th>
<th>17&lt;h&lt;23</th>
<th>23&lt;h&lt;35</th>
<th>35&lt;h</th>
<th>Total Demand Distortion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent (%)</td>
<td>4.0</td>
<td>2.0</td>
<td>1.5</td>
<td>0.6</td>
<td>0.3</td>
<td>5.0</td>
</tr>
</tbody>
</table>

[1] IEEE 1547 – I = The greater of the maximum load current integrated demand over 15 or 30 minutes with the Distributed Generator, or the DG rated current capacity (transformed to the PCC when a transformer exists between the DG and the PCC.

[2] Even harmonics are limited to 25% of the odd harmonic limits shown.

**F. SYNCHRONIZING**

- The DG Facility shall not be manually synchronized unless authorized by the Company. Automatic synchronization shall be supervised by a synch check relay, IEEE Device 25.

- The Company will have the right to review, and inspect the method of synchronization. Automatic synchronizing settings will not be changed following installation unless mutually agreed to by both parties. The Interconnection Customer must install proper sensing devices to sense a de-energized circuit to assure that a de-energized circuit of the Company is not energized.

- The Interconnection Customer shall be solely responsible for synchronizing their generator(s) with the Company’s system. Table V.F.1 shows the IEEE 1547, Table 5, parameter limits for synchronization to the Company’s electrical distribution system.
Table V.F.1 IEEE 1547 Synchronization Parameter Limits for Synchronous Interconnection

<table>
<thead>
<tr>
<th>Aggregate Rating of DG Facility(^1) (kVA)</th>
<th>Frequency Difference (∆f, Hz)</th>
<th>Voltage Difference (∆V, %)</th>
<th>Phase Angle Difference (∆Φ, °)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 500</td>
<td>0.3</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>&gt; 500 – 1,500</td>
<td>0.2</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>&gt; 1,500 – 10,000</td>
<td>0.1</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

\(^1\) Total amount of generation at PCC/POI being synchronized to the Company’s electrical distribution system.

G. ISLANDING

Under certain conditions with extended parallel operation, it would be possible for a part of the electrical power system to be disconnected from the rest of the Company’s electrical grid and have the generation system continue to operate and provide power to a portion of the electrical power system. This condition is called “islanding”.

- It is not possible to successfully reconnect the isolated circuit to the rest of the Company’s system since there are no synchronizing controls associated with all of the possible locations of disconnection. Therefore, it is a requirement that the DG Facility be automatically disconnected from the system immediately by protective relays for any condition that would cause the system to be islanded.

- The DG Facility must either isolate with the Interconnection Customer’s load and/or be blocked from closing back into the electrical power system until the electrical power system is energized for five minutes from the Company’s normal source. Depending upon the size and type of the DG Facility and the electrical power system loads, it may be necessary to install direct transfer trip equipment from the Company’s source to remotely trip the generation system to prevent islanding.

H. RECLOSING

Automatic reclosing of protective equipment exists on the Company’s distribution circuits or transmission circuits. Upon request, these reclosing times for the Company’s source breakers and/or the transmission reclosing times will be provided to the Interconnection Customer. It is the Interconnection Customer’s responsibility to design and maintain their system to properly isolate parallel generation upon loss of the Company’s supply and/or transmission before any reclosing operation.
VI. INTERCONNECTION EQUIPMENT REQUIREMENTS

A. TYPE OF GENERATOR

The Company recognizes three types of generators and an inverter interfaced generator. If the Generating Facility’s generator differs from the following, the next level of study is required per the interconnection process and the protection scheme would require approval from the Company.

1. SINGLE-PHASE INDUCTION GENERATOR

Induction based generators with an inverter as the last device between the DG Facility and the Company’s electric distribution system, or generators with inverters that are NRTL certified may be exempt from the protective relay requirements. The single phase induction generator’s relatively simple protection scheme consists of voltage and frequency relays at the generator that will detect a fault on the distribution line and isolate the generation.

Drawing A1.1 contains Company-approved one-line protection scheme for generators meeting these requirements:

- Grid-interactive inverters (non-grid-interactive or “stand-alone” inverters shall not be used for parallel operation with the Company’s electric distribution system),
- Does not contribute significant fault current, and
- Nameplate capacity is less than 33% of the minimum aggregate load of the circuit as determined by the distribution system study.

2. SMALL THREE-PHASE GENERATOR

Small three phase generators, normally less than 1 MW, can supply greater amounts of energy to a fault on the Company’s electric distribution system; therefore, additional protection is required. An interconnection review/study will determine the specific protective relay.

Drawing A1.2 contains Company-approved one-line protection scheme for generators meeting these requirements:

- Does not contribute significant fault current, and
- Nameplate capacity is less than 33% of the minimum aggregate load of the circuit as determined by the distribution system study.

Drawing A1.3 contains Company-approved one-line protection scheme for generators meeting these requirements:
• Contributes significant fault current, and
• Nameplate capacity is less than 33% of the minimum aggregate load of the circuit as determined by the distribution system study.

3. LARGE THREE-PHASE GENERATOR

Large generators, normally 1 MW or greater, can deliver a significant amount of energy to a fault on the Company's electric distribution system. The level of protection for this class of generation is greater in order to provide high-speed separation of the generation during system disturbances.

Drawing A1.4 contains Company-approved one-line protection scheme for generators meeting these requirements:

• Contributes significant fault current, and/or
• Nameplate capacity is larger than 33% of the minimum aggregate load of the circuit as determined by the distribution system study.

4. INVERTER

Only UL 1741 and IEEE 1547 (grid interactive) rated inverters are permitted to automatically disconnect from the grid in two seconds or less, and cannot reconnect until five minutes of normal utility voltage has occurred.

a. NRTL Certified

Any equipment that is listed as NRTL certified, adequate interconnection protection is typically provided as an integral part of these generation systems. The Interconnection Customer shall confirm that the power inverter used is classified as a non-islanding (grid-tie/utility interactive) inverter conforming to:

• IEEE 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems, or listed as certified according to a Nationally Recognized Testing Laboratory (NRTL) that uses procedures similar to Underwriters Standard, UL 1741, Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems.

Any equipment that is not listed as NRTL certified will require the installation of additional interconnection protection equipment.
b. Fault Detection

A Smart Inverter with Short Circuit Contribution Ratio (SCCR) exceeding 0.1 or one that does not cease to energize Company’s Distribution or Transmission System within two seconds of the formation of an Unintended Island shall be equipped with Protective Functions designed to detect Distribution or Transmission System faults, both line-to-line and line-to-ground, and cease to energize Company’s Distribution or Transmission System within two seconds of the initiation of a fault.

B. EQUIPMENT RATINGS

Electrical equipment provided by the Interconnection Customer shall meet the applicable ANSI and IEEE standards, local codes and state codes.

C. INTERTIE TRANSFORMER

The Company may require, at the Interconnection Customer’s expense, a dedicated transformer or transformers to serve the DG Facility. Since transformer connections and configuration can significantly impact the Company’s electric distribution system operation, the Company allows grounded wye to grounded wye transformer connection configuration. The Company shall review and if determined to be acceptable, then may approve other transformer configurations upon the request of the Interconnect Customer.

D. GROUNDING AND SAFETY ISSUES

All electrical equipment shall be grounded in accordance with local, state, and federal electrical and safety codes and applicable standards.

- Grounding shall be of sufficient size to handle the maximum available ground fault current and shall be designed and installed to limit step and touch potentials to safe levels as set forth in *IEEE Guide for Safety in AC Substation Grounding*, ANSI/IEEE Standard 80.

- The grounding scheme of the DG Facility shall not cause over-voltages that exceed the rating of the equipment connected to the Company’s distribution system and shall not disrupt the coordination of the ground fault protection on the Company’s distribution system.

- The Interconnection Customer is responsible to provide the required grounding for the Generation System. A good standard for this is the IEEE Std. 142-1991, *Grounding of Industrial and Commercial Power Systems*. Ground resistance data collected before the DG Facility is interconnected to the distribution system and after the DG is operating in parallel to
the Company’s distribution system are required to show ground resistance value is consistent with the neutral-earth or stray voltage requirement.

- Additional grounding resistance and/or studies may be required to avoid adverse impact to neighboring customers, such as dairy farms.

E. INTERRUPTING DEVICE

To properly isolate parallel generation from the Company’s system, the Interconnection Customer shall provide an interrupting device with appropriate protective relays and/or other protective equipment capable of interrupting the maximum available fault current at that location. The interrupting device shall be located within the DG Facility in accordance with applicable codes.

Three-phase devices shall interrupt all three phases simultaneously and shall have a separate tripping control independent of the AC source, i.e., a DC battery and charger. This requirement may be waived for generation with a UL 1741 inverter.

F. INTERCONNECTION DISCONNECT SWITCH

A disconnecting device shall be installed to electrically isolate the Company’s electric distribution system from the DG Facility. Depending on system configuration and application, the Company may require that the disconnecting device have load break capability.

The Interconnection Customer is required to provide a utility-accessible, lockable, and visible disconnecting device for use by the Company as a means of electrically isolating the Company system from the generation system and to establish working clearances for maintenance and repair work in accordance with the Company safety rules.

The device shall be a UL-approved or National Electrical Manufacturers Association-approved, manual safety disconnect switch of adequate ampere capacity that meets the following:

- Allows for visual indication of the contact’s position.
- Provides a visible break between the DG Facility and the Company’s electric distribution system in order to establish the safety isolation required for work on the Company’s electric distribution system.
- Shall have a lockable operating handle that can be locked only in the open position with a standard-Company padlock.
- Shall not open the neutral with the switch open
- Be readily accessible 24 hours per day by the Company’s field operating personnel.
• Located at the PCC/POI between the DG Facility and the Company’s electric distribution system, or it may be located at the point where the generation system interconnects with the Interconnection Customer’s load.

• Labeled with a permanent plaque clearly identifying device as the “Interconnection Disconnect Switch”.

• A normally open switch is not an acceptable isolation device between the DG Facility and the Company’s electric distribution system.

• All devices and their locations are subject to approval by the Company.

• The Interconnection Customer shall provide and post its procedure for disconnecting the DG Facility next to the switch, protected from the environment.

• A molded-case type circuit breaker alone is not sufficient, as it does not allow visual indication of contact position. A switchgear rack mount circuit breaker is not allowed to serve as a visible open.

G. RELAYS AND TEST SWITCHES

Protection, control, and monitoring for the DG Facility shall be provided as an integrated microprocessor based relay package. The microprocessor based relay package must be provided unshared, ANSI relay accuracy instrument transformer signals for independent AC current and voltage measurements. The microprocessor-based relay package must have adequate protective function logic, inputs and outputs required to perform the protection required in Section VIII Protection Requirements.

The relaying package shall have a reliable source of power independent from the AC system (DC battery and charger) to assure reliable operation of the protection. Relay trip output contact(s) shall directly energize the trip coil of the DG Facility’s breaker or an intermediate auxiliary tripping relay that directly energizes the breaker trip coil.

All equipment providing relaying functions shall be utility grade devices that meet or exceed ANSI/IEEE Standards for protective relays, i.e., IEEE C37.90, and IEEE C37.90.1.

All relays shall be equipped with setting limit ranges at least as wide as specified in IEEE 1547. Setting limit ranges are not to be confused with the actual relay settings required for the proper operation of the installation. At a minimum, all protective systems shall meet the requirements established in IEEE 1547.

The DG Facility’s system protective equipment shall be located within the DG Facility whenever possible. The DG Facility’s equipment will not be allowed on the Company’s property. The relays shall
be grouped in dedicated panels or cabinets accessible to Company personnel. A heater is required if the relays or battery systems are in an outdoor enclosure.

All relays that are not “draw-out” cased relays shall have appropriate test switches (ABB type FT-1 preferred) to allow testing the operation of the relay without unwiring or disassembling the equipment. The test switch configuration and terminal designation may be reviewed by the Company’s System Protection group upon the Company’s request.

VII. METERING REQUIREMENTS

The Interconnection Customer shall agree to allow the Company to install on their premises the equipment necessary to measure loads and other required data.

The Interconnection Customer may be financially responsible for the installation of Company-owned metering equipment.

- The Company shall furnish electric revenue meters and instrument transformers including secondary wiring.
- The Interconnection Customer shall furnish and install at their expense meter sockets, associated cabinets and enclosures for meter equipment, and all conduits and piping between the instrument transformers and meter sockets and provide a suitable metering mounting location.
- Metering is to be installed according to the Company’s applicable tariff(s), Electric Service Rule Book provisions, and/or contracts.

VIII. PROTECTION REQUIREMENTS

The Interconnection Customer is responsible for providing electrical protection for the Company’s facilities for conditions that arise during parallel-operated generation. The Interconnection Customer is also responsible for providing adequate electrical protection to their facility under any Company operating condition whether or not the parallel generation is in operation. Conditions may include, but are not limited to:

- Single-phasing of supply,
- System faults,
- Equipment failures,
- Abnormal voltage or frequency,
- Lightning and switching surges,
- Excessive harmonic voltages,
- Excessive negative sequence currents and voltages,
- Separation from the Company’s supply (islanding).

The Company requires a high level of protection for all customers. Presence of distributed generation adds another level of requirements in order to protect customer and the Company’s equipment from adverse conditions. These conditions are at a higher risk due to presence of distributed generation on the system.

An interconnection review/study will need to be completed in order to determine which relay protection requirements are needed. Factors that will determine requirements include, but are not limited to the type of generator, winding and grounding configurations, generators contribution to fault current and the generators size compared to the minimum aggregate load of the circuit.

Of highest concern are situations where the DG Facility energizes the Company’s equipment while the Company’s source is disconnected (Island). In general, an increase in level of protection coincides with increasing DG size or if the DG source size is a significant portion of the comparative load on the connected circuit.

For a DG Facility that cannot detect Distribution or Transmission System faults (both line-to-line and line-to-ground) or the formation of an Unintended Island, and cease to energize Company’s Distribution or Transmission System within two seconds, Company may require a Direct Transfer Trip (DTT) system or an equivalent Protective Function. If DTT is required, the Interconnection Customer shall agree to allow the Company to install on their premises the equipment necessary for the Company to provide the DTT functionality. The Interconnection Customer shall agree to provide a reliable power source for the Company DTT equipment and the circuit to tie the Company DTT equipment to the Interconnect Customer breaker trip coil.

Refer to Appendix C for one-line diagrams of Company-approved protection schemes.

The DG Facility’s transformer protection shall include differential, phase and ground fault relays on both the high and low voltage sides of the unit. For transformers rated 10 MVA or less, a power fuse may serve as the high side fault protection and fault-interrupting device instead of the aforementioned transformer relays and associated circuit breaker.

A. PROTECTION COORDINATION

The customer-owned DG Facility which is interconnected to the Company’s electric distribution system shall have protection systems designed such that they operate correctly for faults in the generator, generator step-up (GSU) transformer, circuit breakers, bus, bus connections, or any other DG Facility
equipment and will not cause interruption of the Company’s distribution service to other customers or circuits.

The Interconnection Customer shall submit all protection schemes applied to the Interconnection Customer’s facilities to Company for review. The Company shall have a final review on all protection schemes applied to the Interconnection Customer’s facilities. Any aspects of the DG Facility’s protection schemes that are found to be unsatisfactory by the Company shall be redesigned, changed, or otherwise reworked, then resubmitted to the Company for additional review. Subsequent to final review by the Company of the DG protection schemes, the Interconnection Customer is responsible for providing said protection devices that will protect against faults and disturbances on the Company’s distribution system as well as the DG Facility.

DG Facility’s protective devices must coordinate with the Company’s under frequency load shed (UFLS) program. The DG Facility’s under frequency relays shall be set according to Table V .C.1. The Company’s engineers will evaluate the UF settings on a case-by-case basis and may provide additional requirements.

The Interconnection Customer shall submit all relay settings to the Company for review prior to initial commissioning and prior to any relay setting changes post commissioning. The Company reserves the right to have final review on all DG Facility’s relay settings. Any aspects of the DG Facility’s relay settings that are found to be unsatisfactory by the Company shall be redesigned, changed, or otherwise reworked, then resubmitted to the Company for additional review.

B. EVENT ANALYSIS

The Interconnection Customer shall cooperate with the Company in the analysis of disturbances to either the DG Facility or the Company’s electric distribution system by gathering and providing access to any information relating to disturbances, including information from oscillographs, protective relay targets and reports, breaker operations, power quality monitors, and sequence of events recorders. Any actions, events, or eyewitness accounts of information relating to a disturbance shall also be made readily available within 72 hours of the Company’s request for the records.

IX. COMMUNICATION PATH

A communications channel shall be installed as part of the relay protection scheme for three-phase generators based on the size of the load connected with the local electric distribution system and the aggregate capacity of the DG.

The communication path type and mode will be identified in the System Impact/Distribution System Study. To ensure cohesion, this communication circuit and associated communication equipment at both the DG
Facility and the Company’s facilities shall be purchased and installed by Company personnel at the Interconnection Customer’s expense.

The Interconnection Customer may be required to install, at their expense a communications service from the generator to a location determined by the Company. The Interconnection Customer will be responsible for the local Telecommunications Data Equipment that will support DNP over IP transport to the Company’s dispatch centers. The customer may be responsible for the cost of monthly fees associated with the communications service.

Customer shall list the Company as an authorized agent on the communications service to be able to provide maintenance for the telecommunications equipment and troubleshoot all communications issues.

X. TELEMETERING

The Company shall require the continuous telemetry of power quantities, breaker statuses and alarms for all aggregate generation for the following criteria:

- The aggregate generation output capability is greater than 1 MW and less than or equal to 10 MW (Iowa) or 15 MW (Wisconsin) connected to the Company’s electric distribution system at a voltage 35 kV or less.
- Any customer-owned generation involved in wholesale power transactions.

The Interconnection Customer shall furnish and install, at their expense, the necessary communication equipment, channel(s) and the necessary Company approved telemetering equipment and devices. The Company will determine the most appropriate technology.

A. BASIS FOR CONTINUOUS TELEMETRY

The basis for requiring continuous telemetry for power quantities, breaker statuses and alarms are:

- Determination and monitoring of real-time limit thresholds and/or violations.
- Historical tracking of limit thresholds and/or violations.
- Monitoring of Reactance Power Flows - Real-time and historical.
- Monitoring of Generator On or Off Line Status.
- De-coupling of Generation and Load for Network Applications such as State Estimation and Security Analysis.
XI. COMMISSIONING, TESTING AND MAINTENANCE REQUIREMENTS

In preparation of synchronizing the DG Facility with the Company’s distribution system, the Interconnection Customer is responsible for adhering to the Company’s commissioning, testing and maintenance requirements.

A. COMMISSIONING REQUIREMENTS

The intent of the commissioning process shall be as extensive and complete as specified to provide positive assurance of correct installation and operation of all equipment. The requirements are governed by:

- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- Institute of Electrical and Electronics Engineers (IEEE)
- InterNational Electrical Testing Association (NETA)
- National Electrical Manufacturers Association (NEMA) and Insulated Cable Engineers Association (ICEA)
- National Electrical Safety Code (NESC)
- National Fire Protection Association (NFPA)

The Interconnection Customer is responsible for all costs, associated with relay testing.

The Company shall not be responsible for verifying any control or signal wiring related to the interconnection relay. The Company may witness the operational testing of the interconnection relay system to verify system performs as intended.

B. TESTING REQUIREMENTS

All DG protective relays must be tested and calibrated per manufacturer recommendations and industry standards. The Company reserves the right to trip the intertie interrupting device to verify on demand the calibration of all protective equipment including relays, interrupting devices, etc., at the PCC/POI.

- For installations where the relays and intertie interrupting device(s) are not installed within a Company facility, the Interconnection Customer shall be responsible for maintenance and testing of this equipment. Provisions shall be made for the Company to have access to this equipment for inspection, testing, and control. The Interconnection Customer shall furnish the maintenance documentation and test reports to the Company upon request.
For installations where the relays and intertie interrupting device(s) are installed within a Company facility, the Company shall maintain this equipment and bill the Interconnection Customer for maintenance costs.

1. **TESTING PARAMETERS**

   a. The following data will be collected for **certified** equipment:
      - Device ratings (kW, kV, Volts, amps, etc.);
      - Maximum available fault current in amps;
      - In-rush current in amps;
      - Trip points, if factory set (trip value and timing);
      - Trip point and timing ranges for adjustable settings;
      - Nominal power factor or range if adjustable;
      - If the equipment is certified as Non-Exporting and the method used (reverse power or under power); and
      - If the equipment is certified as Non-Islanding.

   b. The following data will be collected for **non-certified** equipment:
      - The manufacturer or a laboratory acceptable to Company may perform tests;
      - Test results for non-certified equipment must be submitted to Company for supplemental review;
      - Approval by Company for equipment used in a particular DG Facility does not guarantee Company approval for use in other DG Facilities.

2. **TYPE TESTING**

   Table XI.B.2 lists the specific type test and criteria contingent on the DG for certification.

   - **Anti-Islanding Test** – Described in UL 1741 Section 46.3 is required only for devices for with a Certified Non-Islanding designation is desired.

   - **Non-Export Test** – This is required only for devices which a Certified Non-Export designation is desired.

   - **In-Rush Current Test** – Generation equipment that utilizes the Company’s power to motor up to speed will be tested using established procedure to determine the maximum current drawn during this startup process. It is used to estimate Starting Voltage Drop.
- **Surge Withstand Capability Test** – Described in IEEE Standard C62 and C37, to confirm that the surge withstand capability is met, that the equipment did not fail, did not misoperate, and did not provide misinformation.

- **Synchronization Test** – To demonstrate at the moment of the paralleling-device closure, all three synchronization parameters are within the stated limits, and if any of the parameters are outside of the limits that the paralleling-device shall not close (IEEE 1547). The test is repeated five times for each parameter (voltage difference, frequency difference, or phase angle outside of synchronization).

### Table XI.B.2. Type Tests and Criteria for Interconnection Equipment Certification

<table>
<thead>
<tr>
<th>Type Test</th>
<th>Reference</th>
<th>Inverter¹</th>
<th>Synchronous Generator¹</th>
<th>Induction Generator¹</th>
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<tr>
<td>Company Interaction</td>
<td>UL 1741 – 39 &amp; 40</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>DC Isolation</td>
<td>UL 1741 – 40.1</td>
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<td>--</td>
</tr>
<tr>
<td>Simulated PV Array (Input) Requirements</td>
<td>UL 1741 – 41.2</td>
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<td>--</td>
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</tr>
<tr>
<td>Dielectric Voltage Withstand</td>
<td>UL 1741 – 44</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Power Factor</td>
<td>UL 1741 – 45.2.2</td>
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<td>X</td>
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<td>Harmonic Distortion</td>
<td>UL 1741 – 45.4</td>
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<td>X</td>
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<tr>
<td>Company Voltage &amp; Frequency Variation</td>
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<td>Loss of Circuit</td>
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<tr>
<td>Short Circuit</td>
<td>UL 1741 – 47.3</td>
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<td>Load Transfer</td>
<td>UL 1741 – 47.7</td>
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<tr>
<td>Surge Withstand Capability</td>
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<td>Anti-Islanding (for Non-Islanding)</td>
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<tr>
<td>Non-Export (for designation)</td>
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<td></td>
</tr>
<tr>
<td>In-Rush Current (for Company power)</td>
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<td>--</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Synchronization</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

[¹] X = Required; -- = Not Required

### 3. COMMISSIONING TESTS
The Company and/or the Interconnection Customer shall notify the other in advance of performing tests of its Interconnection Facilities and shall notify each other of any modifications to its facilities that are found to be necessary as a result of such testing.

Commissioning tests shall include visual inspections of the interconnection equipment and protective settings to confirm compliance with the interconnection requirements. Company personnel have the right to witness the following commissioning tests which may include, but are not limited to:

- **Equipment Commissioning Tests (Conducted prior to energizing the system)**
  - **Instrument Transformer Tests** – Verify proper wiring, polarity, CT/PT ratios, and proper operation of the protection and measuring circuits. CTs shall be visually inspected to ensure that all grounding and shorting connections have been removed where required.
  - **Verifying Final Protective Relay Function Settings and Testing** – Confirm and document all devices are set to the final review settings. All protective relays shall be calibrated and tested to ensure the correct operation of the protective element. Documentation of all relay calibration tests and settings shall be furnished to the Company.
  - **Trip Test/Checks** – Protective relay control circuits shall be tested to ensure they correctly activate associated interrupting device(s).

- **Direct Trip Transfer / Anti-Islanding Function** (if applicable)
- **Inability to Energize Dead Line**
- **Time Delay on Restart After Company Source is Stable**
- **Company System Fault Detection** (if used)
- **Synchronizing Controls** (if applicable)
- **Grounding** shall be verified to ensure that it complies with this guideline, the NESC and the NEC.
- **Auxiliary Equipment Energization** (600 V and below).
- **Control System Tests** – Remote control, SCADA and remote monitoring tests.
- **Initial Energization** – Verify correct CT/PT secondary values and inputs to protective devices and metering, phase tests, and synchronizing test.
• **Post Energization Tests** – On-line commissioning test including an anti-islanding test will proceed once the Interconnection Customer has completed pre-testing and the results have been reviewed by the Company.

4. **FINAL SYSTEM SIGN OFF**

The Interconnection Customer must submit the commissioning test results to the Company for review before any DG Facility is energized from the Company electric distribution system.

The Company will provide a permission-to-operate letter to the DG Facility owner directly interconnected to the Company’s distribution system contingent upon successfully completing all commissioning tests.

C. **MAINTENANCE REQUIREMENTS**

The Company performs routine maintenance and inspections of its distribution and substation facilities during normal working hours. Maintenance coordination of these facilities takes into account numerous factors, including but not limited to, the capability to serve load, safety, DG requirements, and economics.

- The Company will use Reasonable Efforts to schedule planned inspection and maintenance.
- The Interconnection Customer may request that this maintenance occur outside of normal working hours or meet an expedited schedule. The Interconnection Customer will reimburse the Company for any incremental costs for meeting special schedule requirements.

The Interconnection Customer has sole responsibility for the routine maintenance of their generating and interconnection protective equipment. Maintenance testing will be completed on a cyclical basis per the Company’s standards.

- The Interconnection Customer is encouraged to contact the Company for recommendations regarding maintenance practices and testing intervals of their protective equipment.
- The intertie relay shall be tested on a regular schedule not to exceed five calendar years by the Interconnection Customer.
- The Interconnection Customer must provide all test reports to the Company documenting the existing settings as well as the "as found" and "as left" test results. Any relays found to be performing out of manufacturers recommended limits must be recalibrated, repaired, or replaced before being placed back in service. Operating out of manufacturer recommended limits constitutes a failure of the protective device. The Company shall be notified immediately upon detection of protection systems or components that are found to have failed and/or the status or condition renders them otherwise inoperable. The DG Facility may be curtailed or
disconnected until such failure, status, or condition is remedied in a fashion that is acceptable to the Company.

- Complete maintenance records shall be maintained by the Interconnection Customer and be made available upon request for the Company's review. Failure of the Interconnection Customer to provide proper routine maintenance may result in the DG Facility being required to cease parallel operation.

~*~*~*~
XII. REFERENCES

The following standards shall be used in conjunction with this guideline. When the stated version of the following standards is superseded by an approved revision then that revision shall apply:

- Alliant Energy, Backflow Policy, whitepaper
- Alliant Energy, Electric Service Rule Book
- Alliant Energy, Interconnection Agreement
- Alliant Energy, Power Purchase Agreement
- ANSI C84.1-1995, Electric distribution systems and Equipment – Voltage Ratings (60 Hertz)
- IEEE Std. 100-2000, IEEE Standard Dictionary of Electrical and Electronic Terms
- IEEE Std. 1547, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
- IEEE Std. 519-2014, IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
- Iowa Administrative Code Utilities 199 Chapter 45, Electric Interconnection of Distributed Generation Facilities
- NESC – National Electric Safety Code, ANSI C2-2012, Published by the Institute of Electrical and Electronic Engineers, Inc.
- UL Std. 1741 Inverters, Converters, and Controllers for use in Independent Power Systems
- Wisconsin Administrative Code Chapter Public Service Commission (PSC) 119, Rules for Interconnecting Distributed Generation Facilities
APPENDIX A

DEFINITIONS, ACRONYMS, AND ABBREVIATIONS
The definitions defined in the *IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems* (1547) apply to this document. The following definitions are in addition to the ones defined in IEEE 1547, or are repeated from the IEEE 1547 standard.

**A**

**Alternating Current (AC):** That form of electric current that alternates or changes in magnitude and polarity (direction) in what is normally a regular pattern for a given time period called frequency.

**Ampere (Amp):** The unit of current flow of electricity. It is to electricity as the number of gallons per minute is to the flow of water. One ampere flow of current is equal to one coulomb per second flow.

**Automatic:** Self-acting, operated by its own mechanism when actuated by some impersonal influence as, for example, a change in current strength; not manual; without personal intervention.

**Automatic Reclosing:** A circuit breaker has automatic reclosing when means are provided for closing without manual intervention after it has tripped under abnormal conditions.

**Automatic Tripping (Automatic Opening; Automatic Disconnecting):** The opening of a circuit breaker under predetermined conditions without the intervention of an operator.

**C**

**Capacity:** The number of amperes of electric current a wire will carry without becoming unduly heated; the capacity of a machine, apparatus, or devices is the maximum of which it is capable under existing service conditions; the load for which a generator turbine, transformer, transmission circuit, apparatus, station, or system is rated.

**Circuit:** A conducting path through which an electric current is intended to flow.

**Circuit Breaker:** A device for interrupting a circuit between separable contacts under normal or fault conditions.

**Closed Transition Transfer:** A customer’s source of power is transferred from the electric utility to its own generation and vice-versa while momentarily connecting the two systems together. Here, the Customer’s load is not interrupted at all during the transfer process. The time duration of the momentary parallel (connection) of the two systems together is only long enough to safely start and bring the Customer’s generation into synchronization or to safely shut down the generation. The parallel is typically completed within 30 seconds.

**Current:** A flow of electric charge measured in amperes.

**Current Transformer (CT):** A transformer intended for metering, protective or control purposes, which is designed to have its primary winding connected in series with a circuit carrying the current to be measured or controlled.
A current transformer normally steps down current values to safer levels. A CT secondary circuit must never be open circuited while energized.

D

**Delta Connected Circuit:** A three phase circuit with three source windings connected in a closed delta (triangle). A closed delta is a connection in which each winding terminal is connected to the end (terminal) of another winding.

**Demand:** The rate at which electric power is delivered to or by a system; normally expressed in kilowatts, megawatts, or kilovolt-amperes.

**Direct Current (DC):** An electric current flowing in one direction only and substantially constant in value.

**Direct-Transfer Trip (DTT):** A method of sending a trip signal from one location to another. *Synonymous to transfer trip*

**Disconnect:** A device used to isolate a piece of equipment. A disconnect may be gang operated (all poles switched simultaneously) or individually operated.

**Dispatchable:** Capable of having generator output (real and reactive power) adjusted (“dispatched”) upon request of the Company’s power system operator. The adjustment includes capability to start-up and shut down generating units.

**Distributed Generation Facility (DG Facility):**

**IAC Utilities 199 Chapter 45** - Used by an interconnection customer to generate electricity that operates in parallel with the electric distribution system; a Qualifying Facility typically includes an electric generator and the interconnection equipment required to interconnect safely with the electric distribution system or local electric power system.

**WAC PSC119.02** – A facility for the generation of electricity with a capacity of no more than 15 MW that is located near the point where the electricity will be used or is in a location that will support the functioning of the electric power distribution grid.

**Distributed Resources:** Electrical generation facilities connected to a utility through a Point of Common Coupling

E

**Electric Distribution System:** Equipment and facilities owned and operated by a public utility, including overhead and underground facilities, service entrance equipment, meters, transformers, substations, etc. used to transmit electricity to ultimate usage points such as homes and industries from interchanges with higher voltage transmission networks that transport bulk power over longer distances. The voltage levels at which
the electric distribution systems operate at less than 34kV. "Electric distribution system" has the same meaning as the term "Area EPS," as defined in Section 3.1.6.1 of IEEE Standard 1547.

**Electric Power System:** Consists of generation, distribution, equipment and apparatus owned by the Company including overhead and underground facilities, service entrance equipment, meters, transformers, etc., which make up the central station energy delivery system.

**Emergency:** A condition or situation that in the reasonable good faith determination of the affected party based on Good Utility Practice contributes to an existing or imminent physical threat of danger to life or a significant threat to health, property or the environment.

**Energize:** To apply voltage to a circuit or piece of equipment; to connect a de-energized circuit or piece of equipment to a source of electric energy.

**Energy Losses:** The general term applied to energy lost in the operation of an electrical system. Losses can be classified as transformation losses, transmission line losses or system losses.

**F**

**Fault Current:** The current that is produced by an electrical fault, such as single-phase to ground, double-phase to ground, three-phase to ground, phase-to-phase, and three-phase. The Fault Current is several times larger in magnitude than the current that normally flows through a circuit. A protective device must be able to interrupt this Fault Current within a few cycles. The Fault Current increases when a new generator is interconnected.

**Frequency:** The number of cycles occurring in a given interval of time (usually one second) in an electric current. Frequency is commonly expressed in hertz.

**Fuse:** A short piece of conducting material of low melting point, which is inserted in a circuit for the purpose of opening the circuit when the current reaches a certain value.

**G**

**Generation:** Any device producing electrical energy, i.e., rotating generators driven by wind, steam turbines, internal combustion engines, hydraulic turbines, solar, fuel cells, etc.; or any other electric producing device, including energy storage technologies.

**Generator:** Any device producing electrical energy, i.e., rotating generators driven by wind, steam turbines, internal combustion engines, hydraulic turbines, solar, etc.; or any other electric producing device, including energy storage technologies.

**Generation System:** The interconnected Distributed Generator(s), controls, relays, switches, breakers, transformers, and associated wiring and cables.
Good Utility Practice: Any of the practices, methods and acts engaged in or approved by a significant portion of the electric utility 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.

Ground: A term used in electrical work in referring to the earth as a conductor or as the zero of potential. For safety purposes, circuits are grounded while any work is being done on or near a circuit or piece of equipment in the circuit; this is usually called protective or safety grounding.

Ground Fault: An unintentional electric current flow between one or more energized conductors and the ground

H

Hertz (Hz): The term denoting frequency, equivalent to cycles per second.

I

IEEE (Institute of Electrical and Electronics Engineers): Among other things, the IEEE develops technical standards applicable to the electric industry including relays, transformers, and metering.

Interconnection Customer: The party or parties who are responsible for meeting the requirements of this standard. This could be the Generation System applicant, installer, designer, owner or operator. Any entity that proposes to interconnect its Generating Facility with the electric distribution or transmission system

Interconnection Equipment: Individual or multiple devices used in an interconnection system.

Interrupting Capacity: The amount of current a switch, fuse, or circuit breaker can safely interrupted

Interruption: A temporary discontinuance of the supply of electric power.

Island: A part of an interconnected system may be isolated during a system disturbance and start operating as a subsystem with its own generation, transmission and distribution capability. Then the subsystem becomes an island of the main interconnected system without a tie. In such a case, the islanded system and the main interconnected system will operate at different frequencies and voltages.

K

Kilovolt (kV): 1,000 volts.

Kilovolt-Ampere (kVA): The product of kilovolts times amperes; used to refer to high voltage alternating current systems. One thousand volt amperes; see the definition for Apparent Power.
Kilowatt (kW): An electric unit of power that equals 1,000 watts.

Kilowatt-hour (kWh): A basic unit of electric energy equal to the use of 1 kilowatt for a period of one hour.

KVar: Abbreviation for kilovolt-ampere-reactive. It is a measure of reactive power, which is required to regulate system voltage.

L

Lagging Power Factor: Occurs when reactive power flows in the same direction as real power; stated with respect to the generator, lagging power factor occurs when generator is producing VARs.

Leading Power Factor: Occurs when reactive power flows in the opposite direction of real power; stated with respect to the generator, leading power factor occurs when generator is absorbing VARs.

Line Losses: Electrical energy converted to heat in the resistance of all transmission and/or distribution lines and other electrical equipment, such as transformers, on the system.

Long Term Parallel Operation: During normal operation of the generator, the generator stays electrically interconnected with the electric distribution system.

M

Metering: The methods of applying devices that measure and register the amount and direction of electrical quantities with respect to time.

Metering Equipment: All metering equipment installed or to be installed at the Generating Facility pursuant to the Interconnection Agreement at the metering points, including but not limited to instrument transformers, MWh-meters, data acquisition equipment, transducers, remote terminal unit, communications equipment, phone lines, and fiber optics.

O

One-Line Diagram: A diagram in which several conductors are represented by a single line and in which various devices or pieces of equipment are denoted by simplified symbols. The purpose of such a diagram is to present an electrical circuit or circuits in a simple way so that their function can be readily grasped.

Open Transition Transfer: In this scheme, a customer’s source of power is transferred from Source 1 to Source 2 and vice-versa without momentarily connecting the two sources together. Here, the customer’s load is interrupted momentarily during the transfer process through a mechanical or electrical interlock.

Outage: A condition existing when a line or a substation is de-energized.

Output: The energy delivered by a generation facility during its operation.

Overvoltage: Voltage higher than that desired or higher than that for which the equipment in question is designed.
Parallel Operation: The two-way flow of power between a generator and a distribution system; generators that operate in parallel with a distribution system require additional protection and control devices. This may be contrasted with a stand-alone generator that operates isolated from the utility’s electric system. A customer-owned generator is connected to the Company electric power system for more than 100 milliseconds or 6 cycles. Parallel operation may be required solely for the customer’s operating convenience or for the purpose of delivering power to the Company.

Peak Load: The maximum electric load consumed or produced in a stated period of time.

Peak Shaving: Generator operation that results in reducing customer’s peak load or demand. Closed- transition peak shaving is the condition where the generator is in a parallel operation with the Company’s system. Open-transition peak shaving is the condition where the generator is not connected in parallel with the Company’s electric distribution system.

Point of Common Coupling (PCC): The point where the electrical conductors of the distribution system are connected to the customer’s conductors and where any transfer of electric power between the customer and the distribution system takes place. [WAC PSC 119.02]

Point of Interconnection (POI): The point where the Load or Generation Entities’ conductors or those of the respective agents meet the utilities’ distribution system (point of ownership change). POI has the same meaning as the term “point of common coupling” as defined in Section 3.1.14 of IEEE Standard 1547.

Point of Metering: The point where metering equipment (meters, transducers, current transformers, potential transformers, etc.) is or will be installed to measure the power flow and energy exchange between the Company and the customer.

Power Factor: The ratio of real power (kW) to apparent power (kVA); power factor is the cosine of the phase angle difference between the current and voltage of a given phase.

Power Flow: One-way power flow is the condition where the flow of power is entirely into the customer’s facility.

Power Flow: Two-way power flow is the condition where the net flow of power may be either into or out of the customer’s facility depending on the operation of the generator and other customer load.

Protection: All of the relays and other equipment that are used to open the necessary circuit breakers to clear lines or equipment when trouble develops.

Protective Relay: A device whose function is to detect defective lines or apparatus, or other power-system conditions of an abnormal or dangerous nature and to initiate appropriate control circuit action.
Technical Guidelines and Requirements

Q

Qualifying Facility (QF): A cogeneration facility or a small power production facility that is a qualifying facility under 18CFR Part 292, Subpart B, used by an interconnection customer to generate electricity that operates in parallel with the electric distribution system. A Qualifying Facility typically includes an electric generator and the interconnection equipment required to interconnect safely with the electric distribution system or local electric power system.

R

Reactive Power (VAR): The power that oscillates back and forth between inductive and capacitive circuit elements without ever being used. The function of reactive power is to establish and sustain the electric and magnetic fields required to perform useful work.

Reasonable Efforts: With respect to an action required, by attempting, or taking by a Party under the Standard Generator Interconnection Agreement, efforts that are timely and consistent with Good Utility Practice and are otherwise substantially equivalent to those a Party would use to protect its own interests.

Received Energy: Energy received by the Company from the customer

Reclose: To return a circuit breaker to its closed position after it has opened by relay action.

Relay: A device that is operative by a variation in the condition of one electric circuit to affect the operation of another device in the same or in another electric circuit.

Remote Terminal Unit (RTU): Remotely-located equipment used for collecting data and/or for supervisory control via communication channel.

S

SCADA (Supervisory Control and Data Acquisition): The combination of telemetry and data acquisition and consists of collecting information, transferring it back to a central site, carrying out necessary analysis and control, and then displaying this data on a number of operator screens. It is used to monitor and control a plant, a substation, or other utility installations

SCCR (Short Circuit Contribution Ratio): The ratio of the Generating Facility’s short circuit contribution to the short circuit contribution provided through the Company’s Distribution System for a three-phase fault at the high voltage side of the distribution transformer connecting the Generating Facility to the Company’s Distribution System.

Self-Excited: An electric machine in which the field current is secured from its own armature current
Self-Service or Stand-by Service Generators: Generators operated in parallel with the Company’s electric distribution system only for the purpose of reducing the customer’s peak load. These generators are not normally dispatchable by the Company.

Separately Excited: Use of an exciter for sending current through the field windings of an electric machine in place of taking the field current from its own armature current.

Smart Inverter: A generating facility’s inverter that performs functions that, when activated, can autonomously contribute to grid support during excursions from normal operating voltage and frequency system conditions by providing: dynamic reactive/real power support, voltage and frequency ride-through, ramp rate controls, communication systems with ability to accept external commands and other functions.

Step-Down Transformer: A transformer in which the secondary winding has fewer turns than the primary, so that the secondary delivers a lower voltage than is supplied to the primary.

Step-Up Transformer: A transformer in which the secondary winding has more turns than the primary, so that the secondary delivers a lower voltage than is applied to the primary.

Switch: A device for making, breaking or changing the connections in an electric circuit.

Synchronism: Expresses the condition across an open circuit wherein the voltage sine wave on one side matches the voltage sine wave on the other side in frequency and amplitude without phase angle difference.

System Emergency: Conditions beyond the normal control that affect the ability of the Control Area to function normally including any abnormal system condition which requires immediate manual or automatic action to prevent losses of load, equipment damage, or tripping of system elements which might result in cascading outages or to restore system operation to meet the minimum operating reliability criteria.

Telemetering: Remote measurement of a physical value or status (i.e. generator kV, status of a switch, etc.) by means of a communication channel.

Transfer Trip: A form of remote trip in which a communication channel is used to transmit the trip signal from the relay location to a remote location.

Transformer: An electric device, without continuously moving parts, in which electromagnetic induction transforms electric energy from one or more other circuits at the same frequency, usually with changes of value of voltage and current.

Transmission System: The facilities as defined by using the guidelines established by the Iowa Administrative Code and the Wisconsin Administrative Code. They are owned, controlled or operated by the transmission providers that are used to provide transmission service under the Tariff. Transmission is rated 60 kV or greater.
Utility Grade Relays: Relays that meet IEEE standards C37.90, C37.90.1, and C37.90.2.

VAR: A unit of measurement of reactive power. It is an expression of the difference between current and voltage sine waves in a given circuit.

\[ VA^2 = (Watts)^2 + (VARs)^2 \]

Voltage: Electric potential or potential difference expressed in volts.

Volt-Ampere: A unit of apparent power in an alternating-current circuit equal to the product of volts and amperes without reference to the phase difference, if any. At unity power factor, a volt-ampere equals a watt.

Voltage Regulation: the process and equipment to maintain voltage within acceptable limits.

Watt: The unit of electric power. Watts AC = volts x amperes x power factor (single-phase circuits).

Watt-Hour: A unit of work or energy equivalent to the power of one watt operating for one hour.

Wye or "Y" Connected Circuit (Star Connected): A three-phase circuit in which windings of all three phases have one common connection which may be connected to ground.
## ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>AC</th>
<th>Alternating Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>DC</td>
<td>Direct Current</td>
</tr>
<tr>
<td>DR</td>
<td>Distributed Resource(s)</td>
</tr>
<tr>
<td>DTT</td>
<td>Direct Transfer Trip</td>
</tr>
<tr>
<td>EPS</td>
<td>Electric Power System</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>ISO</td>
<td>Independent System Operator</td>
</tr>
<tr>
<td>MISO</td>
<td>Midcontinent Independent System Operator</td>
</tr>
<tr>
<td>NEC</td>
<td>National Electrical Code</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>PCC</td>
<td>Point of Common Coupling</td>
</tr>
<tr>
<td>POI</td>
<td>Point of Interconnection</td>
</tr>
<tr>
<td>PST</td>
<td>Short-term Flicker</td>
</tr>
<tr>
<td>P.U.</td>
<td>Per Unit</td>
</tr>
<tr>
<td>PV</td>
<td>Photovoltaic</td>
</tr>
<tr>
<td>PWM</td>
<td>Pulse-Width Modulation</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
</tr>
<tr>
<td>SCR</td>
<td>Silicon-Controlled Rectifier</td>
</tr>
<tr>
<td>SSC</td>
<td>Short-Circuit Capacity</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters Laboratories</td>
</tr>
<tr>
<td>VAR</td>
<td>Volt-Ampere-Reactive</td>
</tr>
<tr>
<td>WTG</td>
<td>Wind Turbine Generator</td>
</tr>
</tbody>
</table>
APPENDIX B

LEGEND FOR INTERTIE RELAY AND METERING FUNCTIONS
## Symbol Chart

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="symbol.png" alt="Distribution Transformer" /></td>
<td>A transformer used to change the voltage from a distribution voltage level (2400V-34kV) to a level for use by the customer (typically 277/480V, 120/208V, or 120/240V).</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Fuse" /></td>
<td>A short piece of conducting material of low melting point, which is inserted in a circuit for the purpose of opening the circuit when the current reaches a certain value.</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Disconnect" /></td>
<td>A device used to isolate a piece of equipment. A disconnect may be gang operated (all poles switched simultaneously) or individually operated.</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Circuit Breaker" /></td>
<td>A device for interrupting a circuit between separable contacts under normal or fault conditions.</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Potential Transformer (CT)" /></td>
<td>A transformer intended for metering, protective or control purposes, which is designed to change the voltage from a distribution or utilization voltage level to a level for metering or protection purposes (typically 24V or 48V).</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Current Transformer (CT)" /></td>
<td>A transformer intended for metering, protective or control purposes, which is designed to have its primary winding connected in series with a circuit carrying the current to be measured or controlled. A current transformer normally steps down current values to safer levels. A CT secondary circuit must never be open circuited while energized.</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Relay" /></td>
<td>A device that is operative by a variation in the condition of one electric circuit to affect the operation of another device in the same or in another electric circuit. The number corresponds to a specific relay type. The relay types are shown in the Table on page 6 of this Appendix 1.</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Meter" /></td>
<td>A device used to measure the flow of electricity (in kWh) between Alliant Energy and the customer. The meter may measure flow in one or both directions.</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Generator" /></td>
<td>Any device producing electrical energy, i.e., rotating generators driven by wind, steam turbines, internal combustion engines, hydraulic turbines, solar, etc., or any other electric producing device, including energy storage technologies.</td>
</tr>
<tr>
<td><img src="symbol.png" alt="Ground" /></td>
<td>A term used in electrical work in referring to the earth as a conductor or as the zero of potential. For safety purposes, circuits are grounded while any work is being done on or near a circuit or piece of equipment in the circuit; this is usually called protective or safety grounding.</td>
</tr>
</tbody>
</table>
### Relay Notes

<table>
<thead>
<tr>
<th>Relay Device</th>
<th>Description, Purpose and Setting Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-2</td>
<td><strong>Impedance Relay</strong> (time-delayed). Provide tripping of the customer breaker for faults on transmission or distribution line.</td>
</tr>
<tr>
<td>25</td>
<td><strong>Synchronizing or Synchronism-Check Device.</strong> Provide voltage and phase angle supervision of generator breaker closure.</td>
</tr>
<tr>
<td>27</td>
<td><strong>Undervoltage Relay.</strong> Provide tripping of the customer breaker should the Company line voltage not be maintained within an acceptable lower limit. The relay should be capable of providing a trip time in the ½ to 2-second range. Actual voltage and time delay settings will be determined on a case-by-case basis.</td>
</tr>
<tr>
<td>27N</td>
<td><strong>Neutral Undervoltage Relay.</strong> Provide tripping of the customer breaker for ground faults on the Company system. The relay should be capable of providing a trip time in the ½ to 2-second range. Actual voltage and time delay settings will be determined on a case-by-case basis.</td>
</tr>
<tr>
<td>32</td>
<td><strong>Directional Power Relay.</strong> For Non-Export or Export Limited only. Must sense Real and Reactive Power.</td>
</tr>
<tr>
<td>46</td>
<td><strong>Negative Sequence Relay.</strong> Detects unbalanced conditions on feeders. Protects the interconnection transformer from overloads associated with unbalanced feeder loading.</td>
</tr>
<tr>
<td>50/51</td>
<td><strong>AC Instantaneous/Time Overcurrent Relay.</strong> Provide tripping of the customer breaker in the event of a phase fault on the customer system.</td>
</tr>
<tr>
<td>50/51N</td>
<td><strong>AC Instantaneous/Time Ground Overcurrent Relay.</strong> Provide tripping of the customer breaker in the event of a ground fault on the customer system and for close-in solid ground faults on the Company’s feeder.</td>
</tr>
<tr>
<td>51C</td>
<td><strong>Voltage-Controlled Phase Timed Overcurrent Relay</strong></td>
</tr>
<tr>
<td>51 (P, Q, G)</td>
<td><strong>Timed Overcurrent Relay.</strong> Torque-controlled for direction.</td>
</tr>
<tr>
<td>51G</td>
<td><strong>Time Neutral Overcurrent.</strong> Provide tripping of the customer breaker for excessive distribution line unbalances or presence of a phase-to-ground fault.</td>
</tr>
<tr>
<td>51V</td>
<td><strong>Torque-Controlled Time Overcurrent.</strong> Provide tripping of the customer breaker for faults on the Company's distribution line.</td>
</tr>
<tr>
<td>52</td>
<td><strong>AC Circuit Breaker</strong></td>
</tr>
<tr>
<td>Relay Device</td>
<td>Description, Purpose and Setting Parameters</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>59I</td>
<td><strong>Instantaneous Overvoltage Relay.</strong> Provide tripping of the customer breaker should the Company line voltage not be maintained within an extreme acceptable upper limit. Actual voltage setting will be determined on a case-by-case basis.</td>
</tr>
<tr>
<td>59N</td>
<td><strong>Neutral Overvoltage Relay.</strong> Provide tripping of the customer breaker for ground faults on the Company’s distribution system. The relay should be capable of providing a trip time in the ½ to 2-second range. Actual voltage and time delay settings will be determined on a case-by-case basis.</td>
</tr>
<tr>
<td>59T</td>
<td><strong>Time Overvoltage Relay.</strong> Provide tripping of the customer breaker should the Company line voltage not be maintained within an acceptable upper limit. The relay should be capable of providing a trip time in the ½ to 2-second range. Actual voltage and time delay settings will be determined on a case-by-case basis.</td>
</tr>
<tr>
<td>67 (P, Q, G)</td>
<td><strong>AC Directional Instantaneous Overcurrent Relay</strong></td>
</tr>
<tr>
<td>79 (HB/DL)</td>
<td><strong>AC Reclosing Relay.</strong> Reclose supervised by Hot Bus/Dead Line</td>
</tr>
<tr>
<td>81 O/U</td>
<td><strong>Over/Under Frequency Relay.</strong> Provide tripping of the customer breaker should system frequency not be maintained. This relay would be expected to operate if the customer should become isolated from the Company system (islanding condition). The relay should be capable of providing a trip time in the ½ to 2-second range. Actual frequency and time delay settings will be determined on a case-by-case basis.</td>
</tr>
<tr>
<td>RQM</td>
<td><strong>Revenue Quality Meter</strong></td>
</tr>
<tr>
<td>TS</td>
<td><strong>Test Switch</strong></td>
</tr>
</tbody>
</table>
MEETS REQUIREMENTS FOR GRID-INTERACTIVE INVERTERS, DOES NOT CONTRIBUTE SIGNIFICANT FAULT CURRENT, AND NAMEPLATE CAPACITY IS LESS THAN 33% OF THE MINIMUM AGGREGATE LOAD OF THE CIRCUIT AS DETERMINED BY THE DISTRIBUTION SYSTEM STUDY.

1. TRIP OF EITHER BREAKER IS ACCEPTABLE.
2. INDICATE GROUNDING CONFIGURATION OF GENERATOR OR INVERTER TRANSFORMER IF PRESENT, EX:

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MEETS REQUIREMENTS FOR SMALL THREE-PHASE GENERATORS, NORMALLY LESS
THAN 1.0 MW, THAT DOES NOT CONTRIBUTE SIGNIFICANT FAULT CURRENT, AND
NAMEPLATE CAPACITY IS LESS THAN 33% OF THE MINIMUM AGGREGATE LOAD OF
THE CIRCUIT AS DETERMINED BY THE DISTRIBUTION SYSTEM STUDY.

PARALLEL-OPERATED DISTRIBUTED GENERATION

ONE LINE DIAGRAM
DISTRIBUTED GENERATION PROTECTION SCHEME

SCALE: NONE

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PARALLEL-OPERATED DISTRIBUTED GENERATION
DISTRIBUTED GENERATION
PROTECTION SCHEME

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ONE LINE DIAGRAM

DISTRIBUTED GENERATION

OF THE CIRCUIT AS DETERMINED BY THE DISTRIBUTION SYSTEM STUDY.

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THAN 1.0 MW, THAT CONTRIBUTES SIGNIFICANT FAULT CURRENT, AND NAMEPLATE
CAPACITY IS LESS THAN 33% OF THE MINIMUM AGGREGATE LOAD

NOTES:
1. RELAY SPECIFIED, OWNED & SET
   BY CUSTOMER
2. THE UTILITY HAS THE
   OPTION TO REVIEW
   SETTINGS & TESTS

NOTE:
CURRENT TRANSFORMERS FOR
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