Guidelines for Generation, Tie-Line, and Substation Interconnections

Otter Tail Power Company compiled this document with input from others.

Otter Tail Power Company gratefully acknowledges permission granted by Northern States Power and Georgia Power Company to utilize their "Guide for Interconnection Requirements and Parallel Operation of Customer Owned Generation" as a basis for several sections.

Revision Number	Revision Date	Effective Date	Owner	Summary of Changes
2.1		July 12, 2002	JoAnn Thompson	Creation of document
3.1	Nov. 30, 2009	Dec. 30, 2009	Dean Pawlowski	Reorganization and general update
3.2	Oct. 15, 2010	Dec. 30, 2010	Dean Pawlowski	General Update
3.3	Nov 15, 2013	Nov. 25, 2013	Dean Pawlowski	General Update
3.4	Dec 21, 2018	Jan. 1, 2019	Dean Pawlowski	Metering process documentation

Otter Tail Power Company Guidelines for Generation, Tie-line, and Substation Interconnections, Version 3.4

Otter Tail Power Company

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OTTER TAIL POWER COMPANY GUIDELINES FOR GENERATION, TIE-LINE, AND SUBSTATION INTERCONNECTIONS

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I. INTRODUCTION

A. OBJECTIVES

The purpose of this handbook is to provide technical guidelines to assist the applicant desiring to interconnect with the Otter Tail Power Company electric system ("Otter Tail System") in establishing the interconnection in an efficient and consistent manner to meet the minimum requirements for safe and reliable operation of the parallel interconnection. This document is designed to comply with the North American Electric Reliability Council's (NERC) compliance directive to establish facility connection standards.

These guidelines are not intended to be a design specification or instruction manual but to provide the technical guidance needed to achieve the following:

- Ensure the safety of the general public and Otter Tail personnel.
- Maintain the reliability and service of all users of the Otter Tail System.
- Minimize the possible damage to the property of the general public, Otter Tail Customers, and Otter Tail.
- Minimize adverse operating conditions on the Otter Tail System.
- Permit the applicant to operate in parallel with the Otter Tail System in a safe, reliable and efficient manner.
- Accurately measure and account for all injections and extractions from the interconnected system.

B. AUTHORITY

State and federal regulatory agencies having jurisdiction over Otter Tail's System, require Otter Tail to provide safe and reliable service. The Federal Energy Regulatory Commission (FERC), having authority over the entire interconnected electric grid and all wholesale transactions, has established the NERC operating guidelines as the guiding standards and practices for all jurisdictional utilities. Otter Tail adheres to the existing (or amended) manuals, standards, and guidelines of the NERC, MISO, Applicable Reliability Council, or any successor agency assuming or charged with similar responsibilities related to the operation and reliability of the North American electric interconnected transmission grid.

The requirements set forth by this document are intended to comply with the Public Utility Regulatory Policies Act (PURPA), the FERC's final rules on Open Access (FERC Orders 888, 889), all state and federal regulatory agency requirements and other applicable requirements of other entities related to owners and operators of electric Systems and associated interconnected facilities such as NERC, MISO, Applicable Reliability Council, or any successor agency assuming or charged with similar responsibilities related to the operation and reliability of the North American electric interconnected transmission grid. While these requirements are based on today's industry standards, the electric industry is undergoing a major restructuring and

changes can be expected. The applicant needs to work closely with Otter Tail to keep up to date on the interconnection requirements.

Any applicant desiring to interconnect to the Otter Tail System is required to comply with Otter Tail's requirements.

C. INTERCONNECTION PROCEDURES

The interconnection procedures for establishing interconnection to the Otter Tail Transmission System are pursuant to Attachment X under the MISO Open Access Transmission. Additional information may be found on the Company's website at http://www.otpco.com.

The interconnection procedures for establishing interconnection to the Otter Tail Distribution System are in accordance with the procedures established under the jurisdiction of each state in which Otter Tail provides electric service. A copy of the applicable procedures will be provided to the applicant with a copy of these guidelines. Additional details may also be found on the Company's website at http://www.otpco.com.

All new interconnection applicants should initiate the interconnection process by contacting:

Interconnection Coordinator
Otter Tail Power Company
215 South Cascade Street
Fergus Falls, MN 56538-0496
(218) 739-8947
dpawlowski@otpco.com

D. OTTER TAIL POWER COMPANY AS A BALANCING AUTHORITY AREA OPERATOR

Otter Tail Power Company is the Local Balancing Area Operator for a large geographic area comprising parts of Minnesota, North Dakota, and South Dakota. In light of this operating responsibility, some requirements set forth in these guidelines will be applicable to all interconnections made within the Otter Tail Balancing Authority Area and not exclusively for Otter Tail Customers. Any operations of interconnected equipment or facilities will fall under the direction of the Balancing Authority Area Operator.

All facilities or entities scheduling within, in, or out of the Otter Tail's Balancing Authority Area will be required to sign the Control Area Services and Operations Tariff (CASOT). New interconnections that will not be participating in wholesale transactions or scheduling within, in, or out of Otter Tail's Local Balancing Authority Area may be required to sign a modified agreement for control area services, as some balancing area services may still be required for those facilities.

II. GENERAL POLICY AND REQUIREMENTS

A. COMPLIANCE WITH INTERCONNECTION REQUIREMENTS

It is the responsibility of the applicant to obtain all permits and approvals of the governing bodies and to comply with all applicable electrical and safety codes.

The applicant is responsible for ensuring that the interconnection complies with all NERC, MISO, Applicable Reliability Council, and state planning, design, operating standards – including periodic unit testing, MISO procedures, and the appropriate state procedures.

B. RESPONSIBILITY AND APPROVAL

Approval of the proposed interconnection only ensures that Otter Tail has reviewed the interconnection to make certain that the Otter Tail System can be maintained and that other Otter Tail customers are not adversely affected by operation of the interconnecting Facilities. Otter Tail will not assume any liability or responsibility for applicant-owned equipment.

C. FINANCIAL OBLIGATION ASSOCIATED WITH INTERCONNECTION TO THE OTTER TAIL SYSTEM

Through appropriate agreement(s), Otter Tail may make provisions to recover costs. The following expense categories are examples of (but not all-inclusive of) items reimbursable to Otter Tail:

- Meter installation, tests, maintenance, parts and related labor
- Meter reading and scheduling
- Telemetry installation, tests, maintenance, parts and related labor
- Operating expenses, including communication circuits
- Study analysis and related expenses
- Securing NERC Regional Entity or equivalent acceptance
- Modifications to the Otter Tail System and related labor/engineering
- Protective device installation/equipment cost and related labor
- Protective device settings review and coordination
- Review of design, inspection and testing costs
- Programming costs to incorporate generation and tie-line data into Otter Tail's energy management system
- Land, rights-of-way, licensing, permitting, engineering, etc.
- Control Area Services costs

D. FINANCIAL PENALTIES

If operation of the applicant's Facility causes Otter Tail to be out of compliance with any applicable rules, regulations, and/or requirements of NERC, MISO, Applicable Reliability Council, or any successor agency assuming or charged with similar responsibilities related to the operation and reliability of the North American electric interconnected transmission grid, and if Otter Tail is assessed a penalty, fee, or charge for such non-compliance, said penalty will be passed through to the applicant.

E. REQUESTS FOR TRANSMISSION SERVICE

The ability to interconnect to the Otter Tail System does not mean the applicant can deliver or receive power over Otter Tail's facilities at all times and to any location. This determination is made under the Transmission Provider's Tariff and through reservation of transmission service. If the applicant intends to wheel power over Otter Tail's transmission facilities, the applicant must contact the MISO concerning obtaining transmission service.

F. Generator Tie Line Interconnections

If any interconnection is requested to an Otter Tail generator tie-line facility, the same requirements will be used for this interconnection as to a transmission facility.

III. GENERATION GENERAL INFORMATION

For purposes of this handbook, generation is defined as any device producing (or releasing from storage) electrical energy. Such devices include rotating generators driven by steam turbines, internal combustion engines, or hydraulic turbines; windmills; photovoltaic arrays; fuel cells; battery arrays; or other energy sources with a DC to AC inverter or any other electric generating device. Parallel Operation is defined as the operation of applicant-owned generation with output terminals connected directly or through an intermediary's system to Otter Tail's electric delivery system. Parallel Operation may be long-term or momentary ("make before break," "hot," "soft loading limited parallel," "soft loading extended parallel" "Quick Open", or "closed-transition transfer").

A. INTERCONNECTION TYPES

Identified within this section are general requirements that apply to generating equipment operated in parallel with the Otter Tail System including three-phase and single-phase generators or inverter installations. Some requirements are dependent upon the size of the installation as will be noted in the requirements. Additionally, the requirements to interconnect generation may vary depending upon:

- Whether the interconnection transfer is open or closed.
- The Otter Tail System interconnection voltage.
- Interconnection power flow (one-way or two-way).

- The size, type, or location of the proposed interconnection.
- The scheduling of energy within Otter Tail's Balancing Area.
- State interconnection requirements

The manner in which the installation will operate (parallel vs. isolated) including the transition methods will dictate the required operating procedures and equipment installation of the generator.

Operating procedures and equipment installation will determine the type of transition scheme implemented. The method of transition implemented will be dependant upon the applicant's desired terms and conditions of rates and tariffs associated with transactions and/or alternatively, the applicant's desired method of transition will determine the terms and conditions of rates and tariffs. These conditions can be discussed between the applicant and their Otter Tail interconnection coordinator. For any installation, improper operation will result in action by Otter Tail to remove such hazard in order to safeguard its employees and the general public.

The possible transition operating schemes are listed below.

- **Open Transition / Break Before Make**
  With this transfer switch, the load to be supplied from the Generation is first disconnected from the Otter Tail System and then connected to the Generation. The transfer switch typically consists of mechanical interlocks between the two source contactors that drop the Otter Tail System source before the Generation is connected to supply the load.

  (1) To qualify as an Open Transition switch and thwith limited protection requirements, mechanical interlocks are required between the two source contacts. This is required to ensure that one of the contacts is always open and the Generation System is never operated in parallel with the Otter Tail System. If the mechanical interlock is not present, the protection requirements are as if the switch is a closed transition switch.

  (2) Figure 1 provides a typical one-line of this type of installation.

- **Quick Open**
  The load to be supplied from the Generation is first disconnected from the Otter Tail System and then connected to the Generation, similar to the open transition. However, this transition is typically much faster (under 500 ms) than the conventional open transition transfer operation. Voltage and frequency excursions will still occur, sensitive equipment will typically not be affected with a properly designed system. The transfer switch contains mechanical interlocks between the two source contacts that drop the Otter Tail System source before the generation is connected to supply the load.

(1) Mechanical interlocks are required between the two source contacts to ensure that one of the contacts is always open. If the mechanical interlock is not present, the protection requirements are as if the switch is a closed transition switch.

(2) Figure 2 provides a typical one-line of this type of installation and shows the required protective elements.

- **Closed Transition**
  The Generation is synchronized with the Otter Tail System prior to the transfer occurring. The transfer switch then parallels with the Otter Tail System for a short time (100 msec. Or less) and then the generation system and load disconnects from Otter Tail System. This transfer is less disruptive than the Quick Open Transition because it allows the generation a brief time to pick up the load before the support of the Otter Tail System is lost. With this type of transfer, the load is always being supplied by the Otter Tail System or the generation.

Figure 2 provides a typical one-line of this type of installation and shows the required protective elements. The closed transition switch must include a separate parallel time limit relay, which is not part of the generation control and trips the generation from the system for a failure of the transfer switch and/or the transfer switch controls.

- **Soft Loading Transfer Limited Parallel**
  The generation is paralleled with the Otter Tail System for a limited amount of time (generally less than 1-2 minutes) to gradually transfer the load from the Otter Tail System to the generation system. This minimizes the voltage and frequency problems, by softly loading and unloading the generation system.

  (1) Figure 3 provides a typical one-line of this type of installation and shows the required protective elements.

- **Soft Loading Transfer Extended Parallel**
  The generation system is paralleled with the Otter Tail System in continuous operation. Special design, coordination and agreements are required before any extended parallel operation will be permitted. An Otter Tail interconnection study could be required to identify the issues involved.

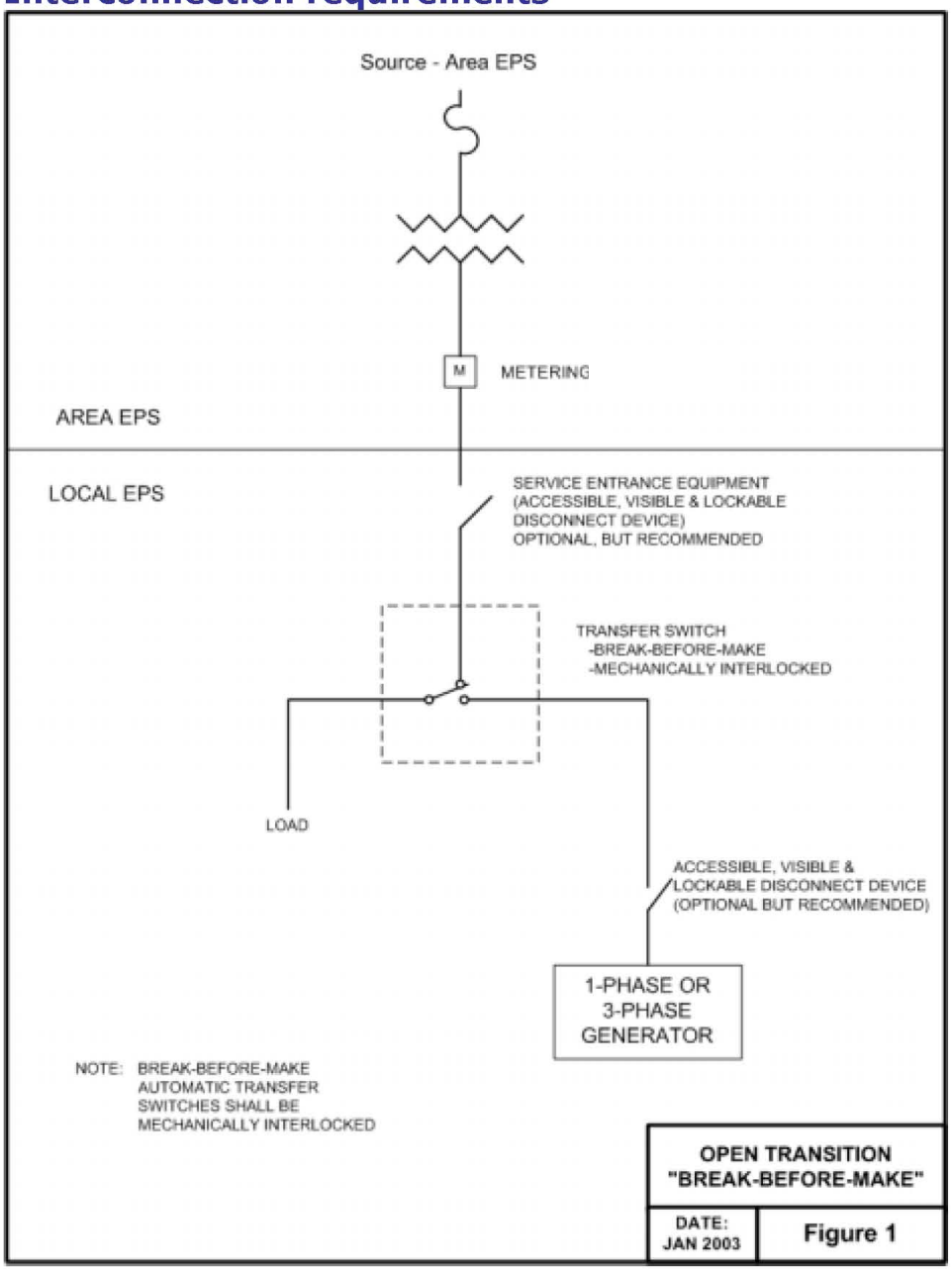
  (1) Any anticipated use in the extended parallel mode requires special agreements and special protection coordination.

  (2) Figure 4 provides a typical one-line of this type of installation and shows the required protective elements.

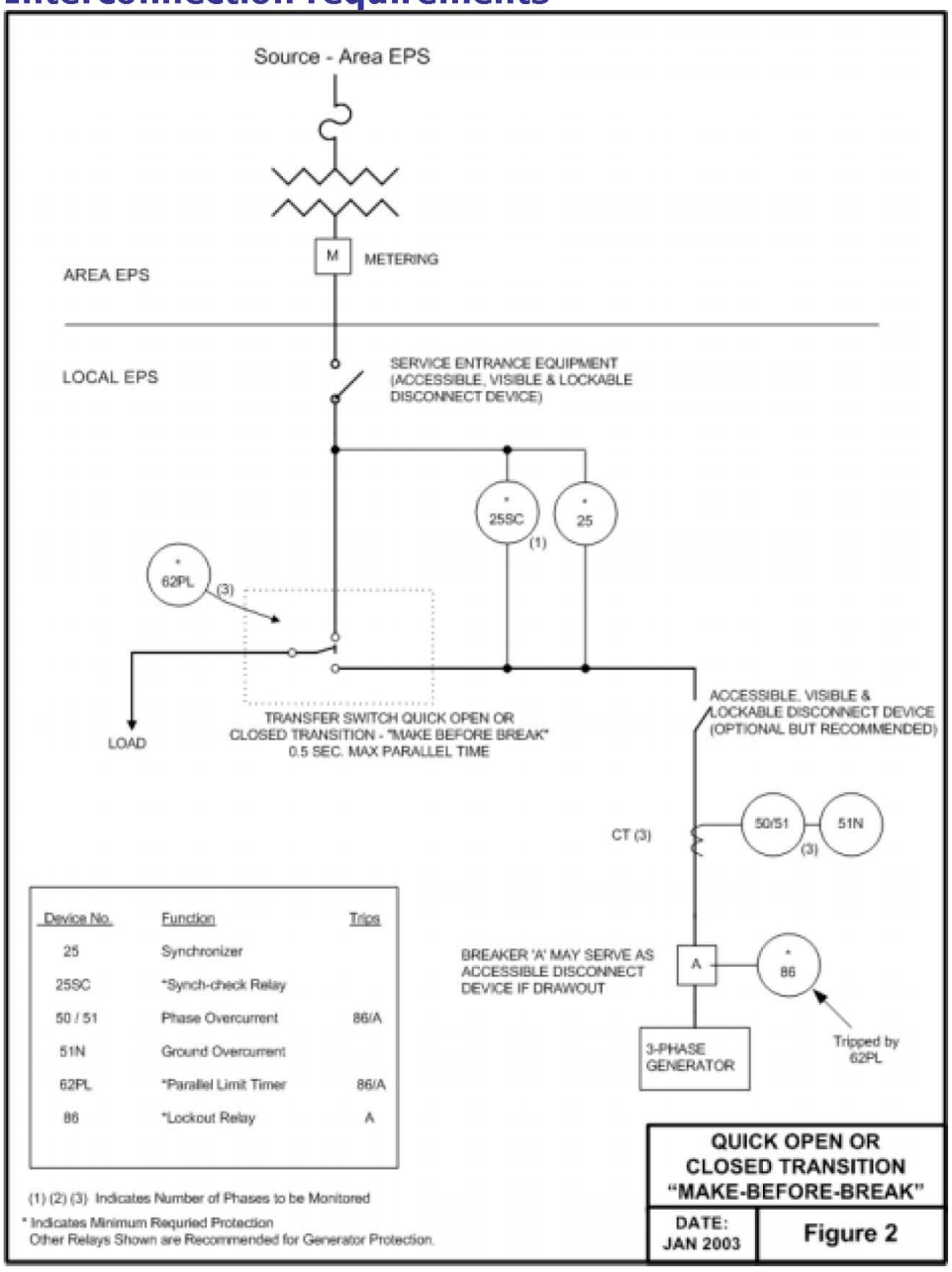
- **Inverter Connected**

This is a continuous parallel connection with the Otter Tail System. Small generation Systems may utilize inverters to interface to the Otter Tail System. Solar, wind and fuel cells are some examples of generation which typically use inverters to connect to the Otter Tail System. The design of such inverters shall either contain all necessary protection to prevent unintentional islanding, or the Interconnection Customer shall install conventional protection to affect the same protection. All required protective elements for a soft-loading transfer switch apply to an inverter connection. Figure 5

Interconnection requirements



Interconnection requirements



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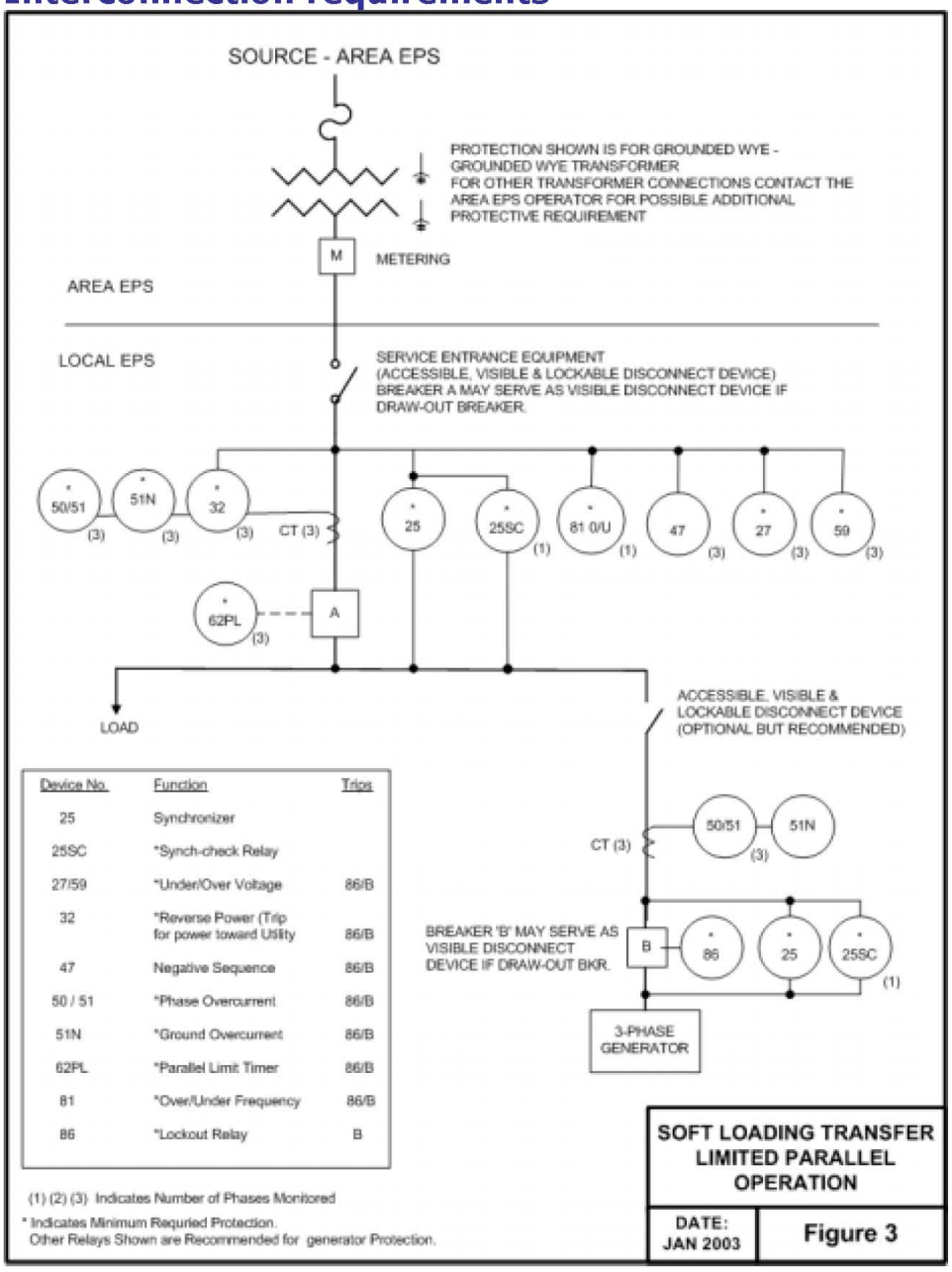

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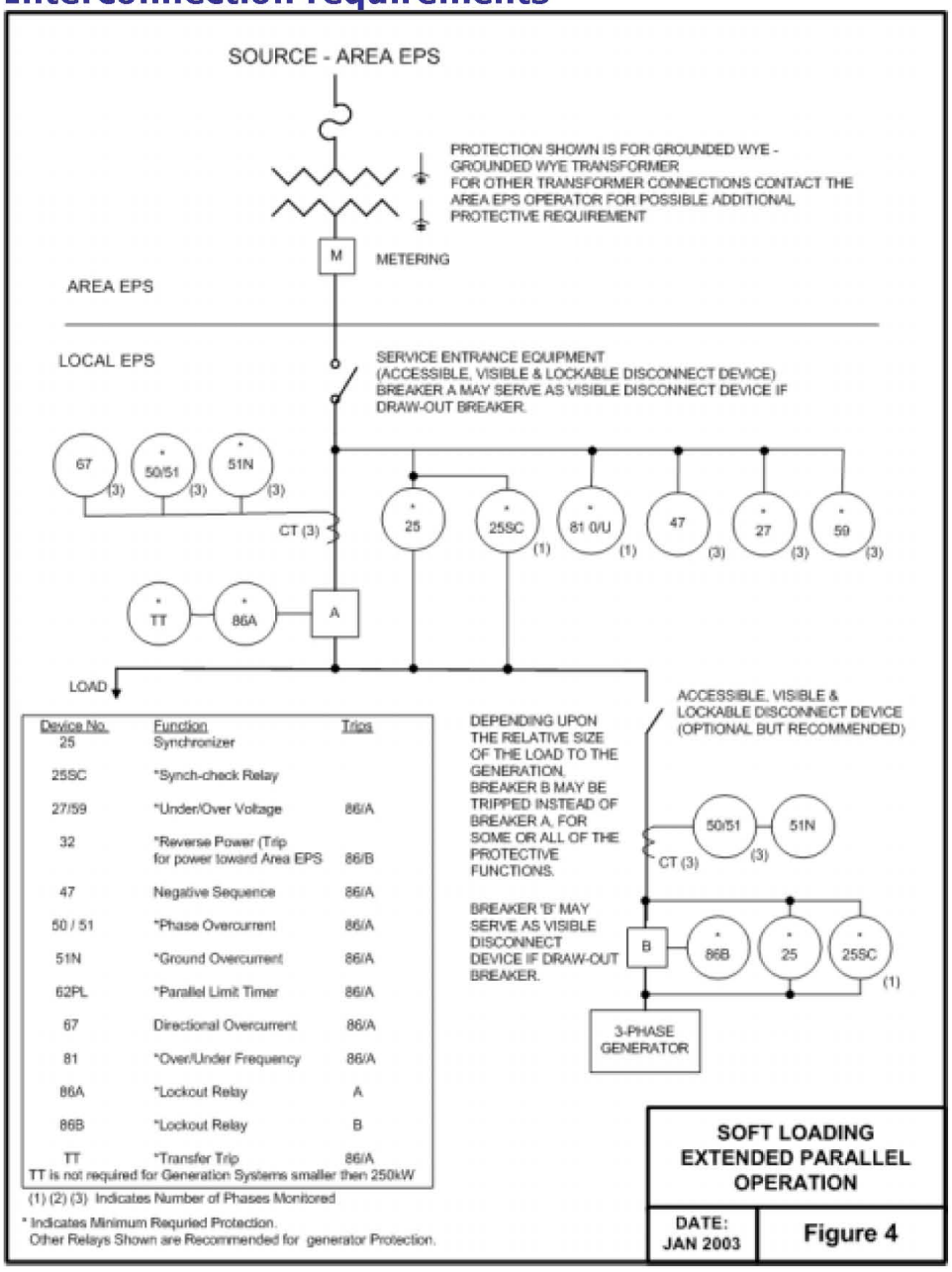
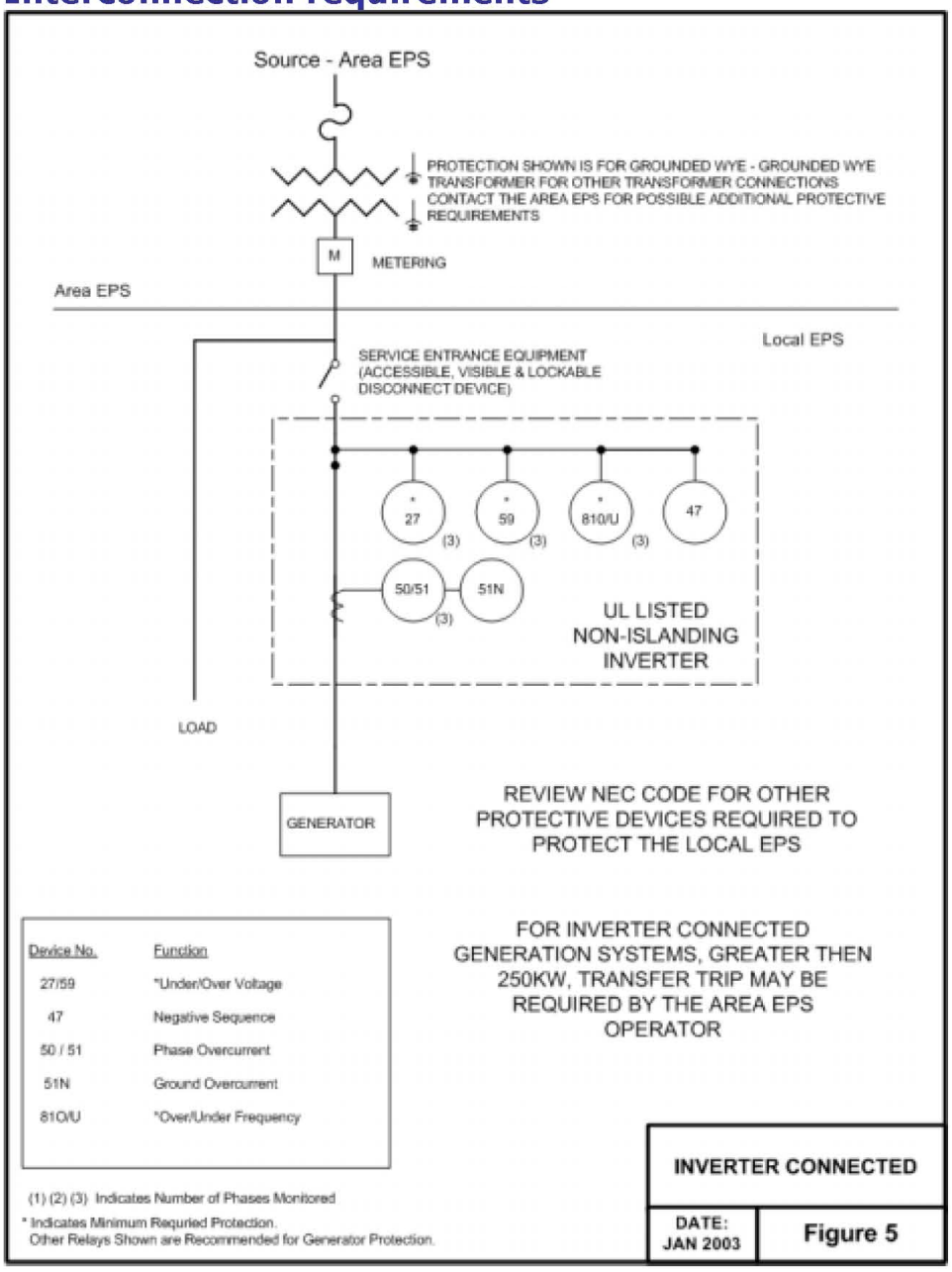


Interconnection requirements



B. GENERATOR CLASSIFICATIONS

For the purpose of this document, applicant-owned generators are classified as either "Self-service" or "Wholesale" generators.

1. Self-service Generators

Self-service generators (Open Transfer, Quick Open, Parallel, or Soft Loading) are those whose purpose is to serve only on-site customer loads and not to deliver power over Otter Tail's or other utilities' electric facilities. At a minimum, these installations must demonstrate to Otter Tail's satisfaction their compliance with the Otter Tail design standards.

2. Net Meter Generator

Net meter generators deliever energy to Otter Tail Power in excess of that received by the generator or load from Otter Tail.

3. Wholesale Generators

Wholesale generators (Soft Loading Extended) are those units where the applicant plans to sell power and/or energy to others or deliver such power over Otter Tail's or another utility's facilities (wheeling). In order for the generator to sell capacity, the generator must be reviewed and approved by MISO and/or the Applicable Reliability Council. Wholesale Generator installations may also be required to receive MISO or Applicable Reliability Council accreditation.

C. REQUIREMENTS FOR GENERATOR TESTING AND PERFORMANCE

1. Generation Testing Requirement

The Wholesale Generation applicant must agree to perform any and all testing of each generator as required by the Applicable Reliability Council and/or the MISO. The specific testing requirements depend on the type of prime mover for the Facility.

D. MODELING REQUIREMENTS FOR GENERATION GREATER THAN 5 MW

All generator/exciter/governor manufacturer data sheets must be available for modeling in transient/voltage stability, short circuit, and relay setting calculation programs. This includes generator reactive capability curves and exciter saturation curves.

At OTP's discretion, the applicant will supply accurate data necessary for transient stability, voltage stability and steady state modeling of the facilities. At a minimum, generator nameplate

data must be specified, including the rated voltage, the MW and MVAR capacity or demand, impedence and the power factor capability of the generator. The actual test data must be provided.

E. ISOLATION POWER TRANSFORMER

To provide maximum operating flexibility for the applicant's generation and to minimize possible adverse effects on other Otter Tail customers, a power transformer may be required between the applicant's generator and Otter Tail-owned equipment. This transformer is usually connected to isolate the zero sequence circuit of the applicant from the zero sequence circuit of the Otter Tail System. During the interconnection process the required transformer connection and grounding configuration will be determined, as well as whether or not a dedicated Otter Tail-owned transformer will be required to serve an applicant with generation. Upgrading of Otter Tail transformer insulation levels and lightning arrester ratings to a higher voltage may be required at the applicant's expense due to the addition of applicant's generation. For units less than 1 MW, the transformer that provides isolation is likely to be the same one already serving customer load. For those units 1 MW or greater, it is likely a dedicated transformer will be added as part of the new unit.

F. GENERATOR STEP-UP TRANSFORMER

The available voltage taps of the applicant's step-up transformer must be reviewed by Otter Tail for its suitability with the Otter Tail System. The applicant is expected to request this review before acquiring the transformer. Otter Tail shall determine which voltage taps would be suitable for a step-up transformer for the Applicant's proposed project. Suitable taps are required to give the transformer the essential capacity for the generator to:

- Deliver maximum reactive power to Otter Tail's System at the Point of Interconnection (generator operating to at least 95 percent lagging power factor).
- Absorb maximum reactive power from Otter Tail's System (generator operating to at least 95 percent leading power factor).
- Help maintain a specified voltage profile on Otter Tail's system for varying operating conditions. Actual voltage tap settings can be different for transformers connected at the same voltage level, depending upon their geographic location.

G. AUTOMATIC GENERATOR CONTROL – 50 MW AND LARGER

The applicant's generator shall be equipped with Automatic Generator Control ("AGC") equipment to permit remote control of the unit and enable the generation to be increased or decreased via Automatic Generation Control. This requirement does not apply if the plant is exempt under NERC, MISO, or Applicable Reliability Council rules due to prime mover or regulatory limitations. Any remote control that is required will be implemented through the

telemetry equipment identified in Section VIII. Certain additional interface signals will be required to implement the remote control.

H. SYNCHRONIZATION OF APPLICANT'S GENERATION

All applicants, independent of generator size classification, are responsible for synchronization of applicant's generation to the Otter Tail System. Before synchronization to the Otter Tail System will be permitted, all required studies, tests and inspections, and contracts must be completed and approved.

IV. COORDINATION WITH OTHER REGIONAL ENTITIES

A. COORDINATION OF STUDIES (R2.1.1)

An Applicant will be required to submit an interconnection application for any new or modified Facility is seeks to interconnect to the Otter Tail System. Depending on the size, type, and location of a new or modified Facility, a study could be performed by either: (1) Otter Tail; or (2) the MISO; or (3) the Applicable Reliability Council; or (4) a neighboring transmission owner; or (5) a neighboring load serving entity; or (6) a neighboring distribution provider. Otter Tail will have a different role to ensure coordination of studies for either new or modified facilities depending on who performs the study.

In the event that a study for a new or modified facility is performed by Otter Tail, the following steps shall be taken:

1. Otter Tail will develop a study scope for the evaluation of a new or modified facility and request participation of interested parties in an ad hoc study group (including neighboring transmission owners, the MISO, the Applicable Reliability Council, neighboring transmission owners, neighboring load serving entities, and neighboring distribution providers).
2. Otter Tail will perform a study of the new or modified facility in accordance with the guidelines and directives of the study scope based on input from the ad hoc study group. The study scope shall include all necessary scenarios to ensure reliability of the System as determined by Otter Tail and its criteria.
3. Otter Tail will share study results and seek input from the ad hoc study group when reviewing study results to formulate coordinated conclusions and recommendations from the study work.
4. Otter Tail will develop a study report documenting study criteria, procedures, assumptions, performance (results), conclusions and jointly developed recommendations for review by the ad hoc study group.
5. Otter Tail will solicit input on the study report by the ad hoc study group and make the necessary revisions based on input from the ad hoc study group.

6. Otter Tail will share the study report with the Applicant once consensus is reached among the members of the ad hoc study group.

When a study for a new or modified facility is performed by a party other than Otter Tail, the following steps shall be taken:

1. Otter Tail will seek involvement to participate in an ad hoc study group for new facilities proposing to interconnect to the Otter Tail System or for existing facilities proposing to be modified.
2. Otter Tail will strive to ensure that the study assumptions, scenerios and procedures proposed by the party performing the study are detailed enough to determine if the new facilities will meet facility connection requirements of Otter Tail.
3. Otter Tail will ensure that criteria are met to maintain acceptable system reliability on the System based on the requirements of Otter Tail.
4. Otter Tail will actively participate in ad hoc study groups and provide comments on study results (when necessary) and assist in formulating conclusions and recommendations of studies.
5. Otter Tail will review study reports and provide comments, as necessary, to ensure that a new facility (or modification of an existing facility) is not degrading the reliability of the System.

B. NOTIFICATIONS OF MODIFICATIONS (R2.1.2)

Upon notification of a new or modified Facility connected to the Otter Tail System, Otter Tail shall take the following steps to ensure that others are informed of the change to the System:

1. Schedule an internal meeting within Otter Tail to gather personnel from all impacted areas (Planning, Operations, Engineering, Relaying, Substations, Communications, etc…)
2. Integrate the system change into the applicable models (MISO (or other Balancing Areas) real-time network and commercial models, MISO (or other Balancing Area) planning model, OTP state estimator model, etc…) and insert (as appropriate) into the MISO (or other Balancing Area) transmission expansion plan process.
3. Depending on the magnitude of the new or modified facility, MISO (or other Balancing Area), the Applicable Reliability Council, neighboring transmission owners, and neighboring load serving entities will be informed, and insert (as appropriate) into the MISO (or other Balancing Authority) transmission expansion plan (through insertion into appropriate process).

V. VOLTAGE LEVEL AND MW AND MVAR CAPACITY OR DEMAND AT POINT OF CONNECTION (R2.1.3)

Any Applicant interested in interconnecting to the Otter Tail System must complete an interconnection application, Appendix A. Among several other characteristics of the planned interconnection, the interconnection application must specify the Point of Interconnection, the voltage level at which the interconnection is desired, and the MW and MVAR capacity (for generation) or MW and MVAR demand (for end-user facilities) expected for the new (or modified) facility.

A completed interconnection application must be reviewed by Otter Tail and will not be deemed complete by Otter Tail until all of the appropriate information is included on the application. Otter Tail will then establish communication with the Applicant upon submittal of a completed interconnection application to begin the interconnection process.

VI. BREAKER DUTY AND SURGE PROTECTION (R2.1.4)

Please refer to section VII.A.5 for fault criteria and section X.A and X.B for surge requirements.

VII. PROTECTION REQUIREMENTS (R2.1.5)

A. FOR ALL INTERCONNECTIONS

This section specifies the protective and control requirements for interconnection requests. An important objective in the interconnection of facilities to the Otter Tail's System is minimizing the potential hazard to life and property. A primary safety requirement is the ability to disconnect immediately when a fault on the System is detected. The protection equipment for an interconnected facility must protect against faults within that facility and faults on the Otter Tail System. No new facility on the Otter Tail System should degrade the existing Otter Tail protection and control schemes or lower the levels of safety and reliability to other customers.

Otter Tail's minimum protection requirements are designed and intended to protect Otter Tail's system only. As a rule, neither party should depend on the other for the protection of its own equipment. Otter Tail shall assume no liability for damage to applicant-owned Facilities resulting from miscoordination between the applicant's protective device(s) and Otter Tail's protective devices. It is the applicant's responsibility to protect its own system and equipment.

Several factors may determine what protective devices are required on the applicant's interconnection. The following three major factors generally determine the type of protective devices required at the Point of Interconnection:

- The type and size of the applicant's interconnecting equipment.
- The location of the applicant on the Otter Tail System.
- The manner in which the installation will operate (one-way vs. two-way energy flow).

The addition of the applicant's Facility may also require modifying the Otter Tail System. These determinants will be made by Otter Tail during an evaluation of a new interconnection . Each interconnection request will be handled individually and Otter Tail will solely determine the protective devices, System modifications, and/or additions required. Otter Tail will work with the applicant to achieve an installation that meets the requirements of both the applicant and Otter Tail. The applicant shall bear all costs allowed for protective devices and Otter Tail System modifications required to permit the operation of the parallel interconnection.

Otter Tail shall operate all Otter Tail-owned protective equipment at the interconnection to ensure that the protection and control requirements and objectives are met. During the interconnection process, Otter Tail will approve the proposed type of interconnection protective devices, ownership, operating details and equipment settings. **Do not confuse interconnection protection in this section with applicant-provided Facility Protection. Otter Tail is not liable or responsible for protection of the applicant's facilities.**

1. Disconnect

A manual disconnect device should be installed to isolate the Otter Tail System from the applicant's Facility. This device must have load break capability or means must be provided to disconnect generation, transmission, or load before operating the disconnect. This disconnect shall open all the poles except the neutral and shall provide a visible air gap to establish required clearances for maintenance and repair work of the Otter Tail system. A breaker that can be racked out into a visibly open position is also acceptable. Otter Tail may require the design to allow the application of safety grounds on the Otter Tail side of the disconnect (or breaker). OSHA lockout/tag requirements must be followed.

The disconnect (or breaker) must be accessible at all times to Otter Tail personnel. Disconnects should allow for padlocking in the open position with standard Otter Tail padlock. The applicant shall not remove any padlocks or Otter Tail safety tags. The disconnect (or breaker) should be located outside of the building if possible. If not possible, applicant must provide access to disconnect (or breaker) at all times (24 hour day phone number, guard desk, etc.) The disconnecting equipment must be clearly labeled. The disconnecting equipment shall be National Electrical Manufacturers Association (NEMA) approved for the specific application and location.

2. Protective Relay Requirements

Protective relays are required to promptly sense abnormal operating or fault conditions and initiate the isolation of the faulted area. Protective relays can generally be categorized into two major groups: industrial grade and utility grade. Utility grade relays have a higher degree of reliability and accuracy and are required in most cases. All Tie-line and Substation Interconnections shall use utility grade relays. The use of Otter Tail-approved industrial grade relays or pre-certified, UL approved, may be permitted on generation installations rated less than 100 kW. Protective relay settings on interconnect breakpoints must be approved by Otter Tail.

Otter Tail requires line-protective equipment to either 1) automatically clear a fault and restore power, or 2) rapidly isolate only the faulted section so that the minimum number of customers are affected by any outage. Fault-interrupting equipment should usually be located at the Point of Interconnection or as close to the Point of Interconnectin as practicable. High-speed fault clearing may be required to minimize equipment damage and potential impact to system stability. The need for high speed fault clearing shall be determined on a case-by-case basis by Otter Tail.

Additional protective relays are typically needed to protect the Generation Facility adequately. Most line relaying depends on generator size and type, number of

generators, line characteristics (i.e., voltage, impedance, and ampacity), and the existing protection equipment connected to the Otter Tail System.

The applicant shall install only Otter Tail approved relays on the part of their system that can impact the operation of the Otter Tail System. These relays must, at a minimum, meet IEEE Standards C37.90, C37.90.1, and C37.90.2. Applicants shall submit complete control and relaying documentation that pertains to protection of the Otter Tail System. Otter Tail may suggest or comment on other areas; however, the applicant is responsible for the design of protection schemes protecting applicant Facilities.

Tables 1 and 2, later in this section, provide protective device recommendations necessary to protect Otter Tail equipment and its customers' equipment against electrical faults (short circuits), degraded voltage or frequency operation, unwanted power flow and inadvertent out of phase closing of breaker/switches. Some protective devices may or may not be required for applicants as determined by Otter Tail on a case-by-case basis. Most line relaying depends on the existing system configuration, the existing protection, and line characteristics such as impedance, voltage, ampacity and available fault duty, at the location under consideration. Generator protection may depend upon the size of the generator, location and nature of interconnection and coordination requirements with Otter Tail protective systems or state interconnection requirements. All necessary protective requirements will be identified an evaluation of any new interconnection request.

3. Reliability and Redundancy

The failure to trip during a fault or abnormal system conditions due to relay or breaker hardware problems, or from incorrect relay settings, improper control wiring, etc. is always a possibility. The protection system must be designed with enough redundancy that failure of any one component still allows the Facility to be isolated from the Otter Tail System under a fault condition. Otter Tail may suggest or require back-up protection. If the Facility's breaker does not trip, the incoming breaker should trip after a predetermined time delay. Similarly, if the incoming breaker fails to trip, the Facility's breaker should trip. Where there is no incoming breaker, the Otter Tail tie breaker may be tripped.

4. Line Protection

Line-protection relays must coordinate with the protective relays at the Otter Tail breakers for the line on which the applicant's Facility is connected. The typical protective zone is a two-terminal line section with a breaker on each end. In the simplest case of a load on a radial line, current can flow in one direction only, so protective relays need to be coordinated in one direction and do not need

directional elements. However, on the typical transmission system, where current may flow in either direction depending on system conditions, relays must be directional. In addition, the complexity and the required number of protective devices increase dramatically with increases in the number of terminals in each protective zone. With two terminals in a protective zone, there are two paths of current flow. With three terminals, there are six paths of current flow, and so on.

In coordinating a multi-terminal scheme, Otter Tail may sometimes require installation of a transmission line protective relay at the applicant's substation site. This is commonly the case whenever three-terminal permissive overreach transfer trip (POTT) schemes or blocking schemes are employed to protect the line. Because this line relay participates in a scheme to protect the Otter Tail System, Otter Tail must ensure the maintenance, testing and reliability of this particular type of relay.

In addition, the breaker's relays must be set to have overlapping zones of protection in case a breaker within any given zone fails to clear. The line protection schemes must be able to distinguish between generation, inrush, load and fault currents. Multiple terminal lines become even more complex to protect. Existing relay schemes may have to be reset, replaced, or augmented with additional relays at the applicant's expense, to coordinate with the applicant's Facility.

The Otter Tail System required relays must be located so that a fault on any phase of the Otter Tail line shall be detected. If transfer trip protection is required by Otter Tail, the applicant shall provide at its expense a communications circuit. This circuit may be a communication line from the telephone company or a dedicated cable. In certain cases power line carrier, fiber optic cable, or microwave communication circuits are also acceptable. The line must have high-voltage protection equipment on the entrance cable so the transfer trip equipment will operate properly during fault conditions.

The Otter Tail System is designed for high reliability by having multiple sources and paths to supply customers. Due to the multiple sources and paths, more complex protection schemes are required to properly detect and isolate the faults. **The addition of any new interconnected facility to the Otter Tail system must not degrade the existing protection and control schemes or cause existing Otter Tail customers to be exposed to lower levels of safety and/or reliability.**

Tables 1 and 2 list the minimum protection that Otter Tail typically requires for any new interconnection. Higher voltage interconnections require additional protection due to the greater potential for adverse impact to system stability and the greater number of customers who could be affected. In some special cases, additional requirements or be subject to state interconnection requirements. The acceptability and additional requirements of these interconnection requests shall be determined by Otter Tail on a case-by-case basis.

Table 1. Basic Line Protection Devices (Protection Needs to be redundant at 41.6 kV and above for all interconnections. For lower voltage interconnections redundancy is only required for some specific areas of the System.)

Protection Device	Device Number	Less than 41.6 kV	41.6 kV to 69kV	115 kV	230 kV
Phase Overcurrent (Radial systems)	50/51	X	X		
Ground Overcurrent (Radial systems)	50/51N	X	X		
Phase Directional Overcurrent	67		X[1]		
Ground Directional Overcurrent or Transformer Neutral	67N 50/51N		X[1]	X[1]	X[1]
Distance Relay Zone 1	21Z1		X[1]	X	X
Distance Relay Zone 2	21Z2		X[1]	X	X
Distance Relay Carrier	21Z2C			X[1]	X
Ground Directional Overcurrent Carrier	67NC			X[1]	X
Distance Relay Carrier Block	21Z3C			X[1]	X
Pilot Wire	87L			X[1]	X
Permissive Overreaching Transfer Trip (POTT) or Hybrid	21/67T			X[1]	X
Power Fail Trip[3]	27		X[1]	X[1]	X[1]
Direct Transfer Trip	TT		X[2]	X[2]	X[2]

[1] May be required depending on local circuit configurations.

[2] Transfer trip may be required on interconnections depending on Otter Tail circuit configuration and loading, as determined by Otter Tail. Typically, transfer trip is required on multi-terminal lines.

[3] Power failure tripping may be required on load tie-line interconnections to facilitate restoration of customer load after a transmission line or area outage.

5. Fault-Interrupting Devices

The fault-interrupting device selected by the applicant must be reviewed and approved by Otter Tail for each particular interconnection.

There are three basic types of fault-interrupting devices:

- Circuit Breakers
- Circuit Switchers
- Fuses

Otter Tail will determine the type of fault-interrupting device required for a Facility based on the available fault duty, the local circuit configuration, the size and type of generation, and the existing Otter Tail protection equipment.

a. Circuit Breakers

Ownership of the intertie circuit breaker will be determined during the interconnection process. However, Otter Tail will have the operational authority to operate all intertie circuit breakers at all installations where the applicant's generation has been classified as greater than 5 MW and for all substation or tie-line interconnections. Upgrading existing circuit breakers within or outside the area of the interconnection may be required at the applicant's expense due to the increased fault current levels.

A three-phase circuit breaker at the Point of Interconnection automatically separates the applicant's Facility from the Otter Tail System upon detection of a circuit fault. Additional breakers and protective relays may be installed in the applicant's Facility for ease in operating and protecting the Facility. The interconnection breaker must have sufficient capacity to interrupt maximum available fault current at its location and be equipped with accessories to:

- Trip the breaker with an external trip signal supplied through a battery (shunt trip).
- Telemeter the breaker status when it is required.
- Lockout if operated by protective relays required for interconnection.

Generally, a three-phase circuit breaker is the required fault-interruption device at the Point of Interconnection, due to its simultaneous three-phase operation and ability to coordinate with Otter Tail devices.

b. Circuit Switchers

A circuit switcher is a three-phase fault-interrupter with limited fault interrupting capability. These devices have typically been used at voltages of 115 kV and below and may substitute for circuit breakers when the fault duty is within the interrupting rating of the circuit switcher. With Otter Tail approval, some circuit switchers with blades can double as the visual open disconnect switch between the metering transformers and the main transformer. Since circuit switchers do not have integral current transformers, they must be installed within 30 feet of the associated current transformers to minimize the length of the unprotected line/bus section.

c. Fuses

Fuses are single-phase, direct-acting sacrificial links that melt to interrupt fault current and protect the equipment. Blown fuses need to be replaced manually after each fault before the Facility can return to service.

Overhead primary fuses shall be replaced by trained, qualified personnel. Because fuses are single-phase devices, all of them may not melt during a fault and therefore would not automatically separate the interconnected Facility from the Otter Tail System. Large primary fuses which do not coordinate with the Otter Tail substation breaker ground relays could cause all the customers on the circuit to lose power due to a fault inside the applicant's interconnected Facility and therefore will not be allowed.

For load-only facilities, Otter Tail may approve the use of fuses if they coordinate with the Otter Tail line-side devices for both phase and ground faults. In limited cases, fuses may be used as a primary protective device (e.g. rural, 60 kV, 70 kV and 115 kV lines, where the applicant's substation is base rate at 10 MW or less). However, if fuses are approved by Otter Tail, the applicant should consider installing a negative sequence relay and/or other devices to protect its Facility against single-phase conditions.

For generation interconnections, fuses cannot be operated by the protective relays and therefore cannot be used as the primary protection for three-phase generation facilities. Fuses may be used for high-side transformer protection for generation less than 5 MW, provided coordination can be obtained with the existing Otter Tail phase and ground protection and if a separate generator breaker provides the required primary protection. Fuses are not permitted for high-side transformer protection for Facilities of 5 MW or greater.

6. Single-Phase Devices - Fuses/Oil Circuit Reclosers

It may be necessary to replace single-phase devices (line fuses, single-phase automatic circuit reclosers) installed between the Otter Tail source substation and the applicant location with three-phase devices. This is to minimize the possibility of single-phasing an applicant's three-phase generator. Single-phase sectionalizing equipment may be installed on the main circuit past the applicant location, or on radial circuits that tap the main circuit between the source substation and the applicant location.

Because the applicant is responsible for protecting its equipment from the effects of excessive negative sequence currents, the applicant must know if there are single-phase devices located between its Facility and the Otter Tail source substation.

7. Automatic Reclosing/Voltage Check Schemes

Otter Tail normally applies automatic reclosing to all transmission and overhead distribution lines. Prior to automatic reclosing, the applicant must ensure that the applicant's Facility is disconnected from the Otter Tail System. It may be necessary to install voltage check schemes at various locations on the Otter Tail System to prevent automatic reclosing in the event that an applicant's Facility remains connected to an isolated, unfaulted section of the Otter Tail System. These voltage check schemes may be located at the Point of Interconnectin, at automatic circuit reclosers on the line feeding the applicant, or on an Otter Tail source substation feeder breaker. These schemes may also be required on alternate circuits that may be used to feed the applicant's Facilities. Details of any modifications to Otter Tail reclosing practices and/or addition of voltage check schemes will be determined during the evaluation of any new interconnection .

Otter Tail shall assume no responsibility for damage to Applicant's equipment due to out-of-phase reclosing.

In general, reclosing practices should be as follows:

- There should be no automatic reclosing for the incoming breaker.
- The Otter Tail substation breaker may have one or more timed recloses, with the first set at a minimum of 2 seconds. It is expected that either the generator or the tie breaker will open before reclosing takes place.
- Where islanding is possible, the Otter Tail substation breaker may need the function of voltage supervision from the tie-line.

B. ADDITIONAL PROTECTION FOR GENERATION INTERCONNECTIONS

The generating unit must meet all applicable American National Standards Institute (ANSI) and Institute of Electrical and Electronic Engineers (IEEE) standards. The prime mover and the generator should be able to operate within the full range of voltage and frequency excursions that may exist on the Otter Tail system without damage to the unit.

1. Special Protection Scheme

The Otter Tail System has been developed with careful consideration for system stability and reliability during disturbances. The type of connection, size of the load, breaker configurations, load characteristics, and the ability to set protective relays will affect where and how Facility's operated. However, the application must meet the applicable reliability council and Otter Tail guidelines.

2. Event Recorder

All unattended generation facilities with a rating greater than 1 MW and with automatic or remotely initiated paralleling capability must have an event recorder that will enable Otter Tail to make an after-the-fact determination of the status of the generation facility at the time of a system disturbance, should such determination be required. The generation facility operator shall ensure that such time reading is correct and synchronized to an accurate time standard. The event recorder or other recording device(s) at the generation facility must be capable of providing a record of (1) the time of any relay operations and targets of the relay that caused the generation facility to separate, if applicable, (2) the time of any paralleling with and separations from the Otter Tail System and (3) the time of the change in voltage-control device set points (if applicable) and (4) the time of change in the operating status (i.e. opened or closed) of any other voltage-control device (i.e., shunt capacitors or reactors). In addition, for generation facilities with a nameplate rating equal to or greater than 10 MW, the event recorder must also provide a record of deliveries to the Otter Tail System of real power in kW and reactive power in kVAr and output voltage in kV.

Table 2. Basic Generator Protection Devices

Generator Protection Device	Device Number	40 kW or Less	41 kW to 400 kW	401 kW and Larger
Phase Overcurrent	50/51	X[1]	X[1]	
Overvoltage	59	X	X	X
Undervoltage	27	X[2]	X	X
Overfrequency	81O	X	X	X
Underfrequency	81U	X	X	X
Ground Over Voltage (ground fault protection for ungrounded system at the applicant's end)	59G	TBD	TBD	TBD
Synchronizing and Reclosing Relays	25	TBD	TBD	TBD
Ground Fault Sensing Scheme (Utility Grade)	51N		X[3]	X
Overcurrent With Voltage Restraint/Voltage Control or Impedance Relay	51V 21		X[4]	X
Reverse Power Relay (Self-Service)	32	X[5]	X[5]	X[5]
Out of Step	68	TBD	TBD	TBD

[1] Overcurrent protection must be able to detect a line-end fault condition. A phase instantaneous overcurrent relay, which can see a line fault under sub-transient conditions, is required. This is not required if a 51V relay is used.

[2] For generators 40 kW or less, the undervoltage requirement can be met by the contactor undervoltage release.

[3] For induction generators and certified non-islanding inverters aggregating less than 100 kW, ground fault detection is not required. For synchronous generators aggregating over 40 kW, ground fault detection is required.

[4] A group of generators, each less than 400 kW but whose aggregate capacity is greater than 400 kW, must have an impedance relay or an overcurrent relay with voltage restraint located on each generator greater than 100 kW.

[5] For "Self-service" generator installations, under the proper system conditions, a set of three single-phase, very sensitive reverse power relays, along with the dedicated transformer may be used in lieu of ground fault protection. The relays shall be set to pick-up on transformer magnetizing current, and trip the main breaker within 0.5 second. Reverse Power (32) toward Otter Tail System where the Generator is not selling power to Otter Tail. Reverse Power (37-50 package) for faults on source line when low side can be looped.

TBD = to be determined on a project-by-project basis

VIII. METERING AND TELECOMMUNICATIONS (R2.1.6)

A. COMMON

1. Metering

The metering scheme shall be designed such that energy (kWh) delivered to the transmission system is net generation and energy (kWh) delivered to the customer is load. Thus for a generator interconnect, station service is load, when generator ouput is less than station service.

Modifications to the revenue metering are usually required for any new interconnection. In general, the metering equipment will need to measure both delivered and received energy (both Watts & VArs). This is typically accomplished by replacing an existing watt-hour meter with a multi-function bi-directional meter. This allows proper measurement of both real and reactive energy in both directions. The metering installation shall be electrically connected on the line side of the main generator disconnect, thus allowing the meter to be read even when the generator is not running.

Net metering is allowed for generation this is a small qualifying facility (per state jurisdiction).

For substation metering, the meter is typically located on the high side of the step-down transformer, thus including the transformer losses.

2. Metering Accuracy, Testing, and Repair

    a. Metering Accuracy

    The metering shall adhere to the accuracy standard specified in ANSI standard C-12.1 applicable at the time the metering is installed. Any current or potential transformers that are used for metering will adhere to the "Accuracy Classifications for Metering" listed in ANSI standard C-57.13.

    b. Periodic Testing

    The metering equipment shall be tested periodically, and re-calibrated to maintain the required accuracy. The meter testing frequency shall at a minimum be based on industry accepted practices and guidelines outlined in ANSI standard C-12.1. Otter Tail's present testing practices are based on the type of metering situation and the jointly agreed to requirements of both parties involved. Typically, the metering equipment at non-Otter Tail sites is tested every three years.

    The periodic test frequency for the metering equipment will be decided upon during the evaluation of a new interconnection.

    Otter Tail and the applicant shall both participate in the periodic testing. The party performing the testing must notify the witnessing party with at least a week's notice, preferably more. If the proposed date is not acceptable, then an alternative time acceptable to both parties must be worked out.

The owner of the meter shall analyze and distribute any maintenance, repair, and test results to all parties receiving the meter readings.

c. Meter and Telemetry Equipment Repair

The owner of the metering and telemetry equipment is responsible for ensuring that the equipment is adequately maintained and is repaired within a reasonable time after a failure is detected. The repair or replacement of a bad meter must be completed within 24 hours after it has been detected. If the metering cannot be repaired within that time, Otter Tail may request the applicant to open the interconnection until the meter has been repaired.

All changes, repairs, and replacements of the meter must be coordinated with the Otter Tail Meter Department. This assures Otter Tail that the meter is functioning properly.

3. Metering and Telemetry Function Requirements

The meter and telemetry requirements define Otter Tail's required functionality for meters, metering related equipment (phone lines, phone circuits, current transformers, potential transformers, etc.) and telemetry equipment (Remote Terminal Units (RTUs), transmitters, receivers, etc.). They do not represent design standards for the metering equipment.

Three major factors generally determine the type of metering and telemetry required:

1. The type and size of the applicant's Facility equipment.
2. The location of the applicant on the Otter Tail System.
3. The manner in which the installation will operate (one-way vs. two-way power flow).

Each request for interconnection will be handled individually and Otter Tail will solely determine the metering and telemetry modifications and/or additions required. Otter Tail will work with the applicant to achieve an installation that meets the requirements of both the applicant and Otter Tail. The applicant shall bear the costs of metering and telemetry modifications required to permit the operation of a parallel interconnection.

1. Measured Values and Metering Equipment Required For Generating Stations With A Net Output Capacity (generation less auxiliaries) Less than 1 MW

a. Bi-directional Real Energy Usage/Output (Watt-hours)
b. Power factor or Reactive Energy Usage (Power Factor or VAr-hours)
c. Interval Recorder to capture hourly energy use

2. Additional Measured Values For Generating Stations With A Net Output Capacity Greater Than Or Equal to 1 MW
   a. Bi-directional Real Power Flow (Watts)
   b. Bi-directional Reactive Power Flow (VArs), at Otter Tail's discretion
   c. Voltage at the Point of Interconnection to Otter Tail System (Volts), at Otter Tail's discretion

3. Additional point for units requiring Telemetry Generating Stations with a net output capacity of 5 MW or greater
   a. Position (open/close) of generator breaker(s) and incoming and tie breakers (if present)
   b. Remote Terminal Unit or Data Link to telemeter all measured values to Otter Tail's Energy Management System (EMS).
4. Measured Values and Metering Equipment Required For Transmission Interconnections that create a new boundary between Local Balancing Areas
   a. bi-directional Real Power Flow (Watts)
   b. bi-directional Reactive Power Flow (VArs)
   c. Voltage at the Point of Interconnection to Otter Tail System (Volts), at Otter Tail's discretion
   d. Interval Recorder to capture hourly energy use
   e. Remote Terminal Unit or Data Link to telemeter all measured values to Otter Tail's SCADA System.

5. Measured Values and Metering Equipment Required For Load Interconnections to Transmission System (non-parallel interconnection)
   a. Real Power Flow (Watts)
   b. Reactive Power Flow (VArs)
   c. Interval Recorder to capture hourly energy use

5. Energy Losses

If the energy is not measured at the point where the energy exchange between Otter Tail and the applicant has been defined by contract, energy losses must be determined. Accounting for the losses may be either done by attributing losses to the monthly accounting of exchanged energy or by attributing losses directly to the energy registered on the meter. The latter case requires a compensated billing meter. Losses applied internal to the meter frequently result in a more complex

metering and telemetering situation and, therefore, should be evaluated thoroughly before this approach is used.

Transmission System Losses may not be applied through a compensated meter. If the energy is not purchased by Otter Tail, and it is wheeled across Otter Tail's System, Otter Tail will require the Applicant to pay for Transmission System Losses.

Energy losses may be subject to change. If the connection to the applicant's Facility changes or Otter Tail or other utilities files new loss rates, Otter Tail and the applicant must re-evaluate the losses to be applied and incorporate any new loss factors into the metering and/or accounting.

6. Meter Reading

General practice within NERC, the MISO, and the Applicable Reliability Council require that meter readings take place at midnight on the meter read day. For most cases, the meter read day will be the last day of the month.

A read through midnight of the billing day could be captured by physically reading the meter at midnight, storing the midnight reading and taking a reading of the stored value the following day (for meters with that capability) or remotely reading the meter at midnight (via a phone line or other communication technologies). Energy readings though midnight can also be approximated by using the hourly energy usage captured in Otter Tail's EMS or on the interval recorder to extrapolate the value from the time the meter was read to midnight on the billing day. The specific method will be decided during the evaluation of a new interconnection.

There may be situations where it is cost effective or necessary to access the metering equipment via telephone. Otter Tail is willing to share an existing phone line with the applicant, but it may be necessary to install a new line. The communications circuit cost (telephone lines or other communication technology) to allow remote reading of the meter at a non-Otter Tail Facility should be borne by the party contracting with Otter Tail or the applicant to supply or purchase energy.

B. TELEMETRY

The requirements for telemetry are based on the need of the System Control Center to protect all users of the System from unacceptable disturbances. The need for requiring telemetry may include the ability to monitor the following conditions:

- Detecting Facility backfeed onto otherwise de-energized lines

- Providing information necessary for reliable operation of Otter Tail equipment (feeders, substation, etc.) during normal and emergency operation
- Providing information necessary for the reliable dispatch of generation

Telemetry is required by Otter Tail when:

- The possibility of islanding a portion of Otter Tail's System exists (typical of smaller feeders).
- 1 MW or larger generator becomes a significant portion of a feeder's total load (typically 6 to 10 MW).
- There is the potential for multiple applicants to have generators on the same substation and/or feeders.
- There is the potential for backfeeding onto the Otter Tail System.
- The Facility plans to provide its own ancillary services.
- There is intent to sell power and energy over Otter Tail Facilities.
- The Facility is required to meet the manual load shed requirement.
- 41.6 kV or 69 kV substations are equipped with circuit breakers and for all substations classified at 115 kV and above.
- FERC requires telemetering for normally open or emergency tie connections.

If "islanding" is a possibility, it will be identified during the evaluation of the enw interconnection. In such instances, the following telemetry may be required:

- Real and reactive power flow for each generator (kW and kVAr)
- Voltage representative of the Otter Tail service to the Facility
- Status (open/close) of Facility and interconnection breaker(s)
- Position of incoming and tie breakers or switches
- Energy output of the generators (kWh)
- applicant load from Otter Tail service (kW and kVAr)

When telemetry is required, the applicant must provide the communications medium to Otter Tail. If a telephone circuit is used, the applicant must also provide the telephone circuit protection and coordinate the RTU addition with Otter Tail. High capacity interconnections may require redundant metering and telemetering.

C. COMMUNICATION CHANNEL

Otter Tail may require that a communication channel and associated communication equipment be installed as part of the protective scheme. This channel may consist of power line carrier, leased telephone line, pilot wire circuit, fiber optic cable, radio, or other means. The communication channel is required in cases where it is necessary to remotely send a signal to remove the applicant's Facility from the Otter Tail System due to a fault or other abnormal

conditions that cannot be sensed by the protective devices at the applicant's location. Some instances may require installation of communication equipment in Otter Tail substations to initiate the protective signals. Otter Tail shall be reimbursed by the applicant for the cost of this equipment and its installation.

Another communication channel may be needed for monitoring and control purposes. Telemetry requirements were previously addressed in this section. Specific communication channel requirements will be determined during the interconnection study process. The cost of installation and additional monthly fees for this channel will be the responsibility of the applicant.

IX. GROUNDING AND SAFETY ISSUES (R2.1.7)

A. SAFETY AND ISOLATING DEVICES

At the Point of Interconnection to the Otter Tail System, an isolating device, which is typically a disconnect switch, shall be provided that physically and visibly isolates the Otter Tail System from the applicant's Facilities. All switchgear that could energize equipment shall be visibly identified (tagged), so that all maintenance crews can be made aware of the potential hazards. Such devices shall:

- Simultaneously open all phases (gang-operated) to the connected Facilities.
- Be accessible by Otter Tail and may be under Otter Tail System Operator jurisdiction.
- Be lockable in the open position by Otter Tail.
- Not be operated without advance notice to either party, unless an emergency condition requires that the device be opened to isolate the Interconnected Facilities.
- Be suitable for safe operation under the conditions of use.

Otter Tail personnel may lock the device in the open position and install safety grounds if:

- It is necessary for the protection of maintenance personnel when working on de-energized circuits.
- The interconnected Facility or Otter Tail equipment presents a hazardous condition.
- The interconnected Facility interferes with the operation of the Otter Tail System.
- The Otter Tail System interferes with the operation of the interconnected Facility.

B. ENERGIZATION OF OTTER TAIL EQUIPMENT BY THE APPLICANT

No applicants, independent of interconnection type or generator size, shall energize a de-energized Otter Tail circuit. The necessary control devices shall be installed by the applicant on the applicant's Interconnection Facilities to prevent the energization of a de-energized Otter Tail circuit. Connection may be accomplished only via synchronization with the Otter Tail System. All interconnecting circuit breakers/devices and all breakers/devices that tie another source to the

Otter Tail System will require synchro-check relaying, other than quick open transition (break before make) transfer switch installations. Authorization to energize a circuit may only be provided by the Balancing Authority Area System Operator.

C. SUBSTATION GROUNDING

Each generation site and/or Interconnection substation must have a ground grid that solidly grounds all metallic structures and other non-energized metallic equipment. This grid shall limit the ground potential gradients to such voltage and current levels that will not endanger the safety of people or damage equipment which are in, or immediately adjacent to, the station under normal and fault conditions. The size, type and ground grid requirements are in part based on local soil conditions and available electrical fault current magnitudes. In areas where ground grid voltage rises are not within acceptable and safe limits (due for example to high soil resistivity or limited substation space), grounding rods and wells can be used to reduce the ground grid resistance to acceptable levels.

If the generation site is close to another substation, the two ground grids may be isolated or connected. If the ground grids are to be isolated, there may be no metallic ground connections between the two substation ground grids. Cable shields, cable sheaths, station service ground sheaths, and overhead transmission shield wires can all inadvertently connect ground grids. Fiber-optic cables are an excellent choice for telecommunications and control between two substations to maintain isolated ground grids. If the ground grids are to be interconnected, the interconnecting cables must have sufficient capacity to handle fault currents and control ground grid voltage rises. Otter Tail must approve any connection to an Otter Tail substation ground grid.

The interconnection of lines and/or generation may substantially increase fault current levels at nearby substations. Modifications to the ground grids of existing substations may be necessary to keep grid voltage rises within safe levels. The interconnection study will determine if modifications are required and the estimated cost.

The Reference section of this document supplies a list of ANSI/IEEE technical resources for grounding.

X. INSULATION AND INSULATION COORDINATION (R2.1.8)

Power system equipment is designed to withstand voltage stresses associated with expected operation. Adding or connecting new Facilities can change equipment duty, and may require that equipment be replaced or switchgear, telecommunications, shielding, grounding and/or surge protection added to control voltage stress to acceptable levels. Interconnection studies may identify additional requirements to maintain an acceptable level of Otter Tail System availability, reliability, equipment insulation margins, and safety.

Voltage stresses, such as lightning or switching surges, and temporary overvoltages may affect equipment function. Remedies depend on the equipment capability and the type and magnitude of the stress. In general, stations with equipment operated at 15 kV and above, as well as all transformers and reactors, shall be protected against lightning and switching surges. Typically, this includes station shielding against direct lightning strokes, surge arresters on all wound devices, and shielding with rod gaps (or arresters) on the incoming lines. The following requirements may be necessary to meet the intent of Otter Tail's reliability criteria.

A. SURGE PROTECTION

The Interconnection shall have the capability to withstand voltage and current surges in accordance with the environments defined in IEEE/ANSI C62.41 and IEEE C37.90.1.

Otter Tail highly recommends the applicant to install surge arresters for protection of transformers and other vulnerable equipment. Arresters shall be mounted in such a manner as to protect any of Otter Tail's facilities from surge voltages. In general, all OTP incoming lines shall be protected with surge arresters located on the line side of the disconnect switch. All lines connecting to an Otter Tail substation shall include either rod gaps or surge arresters for substation entrance protection. Otter Tail staff will recommend the appropriate level of entrance protection as well as other specifications for surge arresters during the interconnection process.

B. LIGHTNING SURGES

If the Requester proposes to tap a shielded transmission line, the tap line to the substation must also be shielded. For an unshielded transmission line, the tap line does not typically require shielding beyond that needed for substation entrance. However, special circumstances such as the length of the tap line may affect shielding requirements.

Lines at voltages of 69 kV and higher that terminate at Otter Tail substations must meet additional shielding and/or surge protection requirements. Incoming lines must be shielded for ½ mile at 69-229 kV and 1 mile at 230 kV and higher. Rod gaps must also be installed at the station entrance. For certain customer service substations at 230 kV and below, Otter Tail may require only an arrester at the station entrance in lieu of line shielding, or a reduced shielded zone adjacent to the station. These variations depend on the tap line length, the presence of a power circuit breaker on the transmission side of the transformer, and the size of the transformer. Such exceptions can be discussed with Otter Tail during the interconnection process.

C. TEMPORARY OVERVOLTAGES

Temporary overvoltages can last from seconds to minutes, and are not characterized as surges. These overvoltages are present during islanding, faults, loss of load, or long-line situations. All new and existing equipment must be capable of withstanding these duties. Temporary overvoltages on the Otter Tail System may fall within the voltage range shown on Table 3.

1. Islanding

A ‘local island’ condition can expose equipment to higher-than-normal voltages. Special relays to detect this condition and isolate the Interconnection Facility from the Otter Tail System may be required.

2. Neutral Shifts

When generation or a source of ‘back-feed’ is connected to the low-voltage side of a delta-grounded wye customer service transformer, remote end breaker operations initiated by the detection of faults on the high-voltage side can cause overvoltages that can affect personnel safety and damage equipment. This type of overvoltage is commonly described as a neutral shift and can increase the voltage on the unfaulted phases to as high as 1.73 per unit. At this voltage, the equipment insulation withstand-duration can be very short. Several alternative remedies are possible:

- Provide an effectively grounded system on the high-voltage side of the transformer that is independent of other transmission system connections.
- Size the high-voltage-side equipment to withstand the amplitude and duration of the neutral shift.
- Rapidly separate the back-feed source from the step-up transformer by tripping a breaker using either remote relay detection with pilot scheme (transfer trip) or local relay detection of an overvoltage condition.

Effectively grounded is defined as an $X_0/X_1 \leq 3$ and $R_0/X_1 \leq 1$. Methods available to obtain an effective ground on the high-voltage side of the transformer include:

- A transformer with the transmission voltage (Otter Tail’s) side connected in a grounded-wye configuration and low voltage (Connection Point) side in closed delta.
- A three-winding transformer with a closed-delta tertiary winding. Both the transmission and distribution side windings are connected in grounded wye.
- Installation of a grounding transformer on the transmission voltage (Otter Tail) side.

Any of these methods result in an effectively grounded system with little risk of damage to surge arresters and other connected equipment.

XI. VOLTAGE, REACTIVE POWER, AND POWER FACTOR CONTROL (R2.1.9)

A. VOLTAGE

The applicant's equipment shall not cause excessive voltage excursions. The applicant shall provide an automatic means of disconnecting its equipment from the Otter Tail System within three seconds if the steady state voltage cannot be maintained within the required tolerance.

Most of Otter Tail's system at 12.5 kV and below is voltage regulated. When the interconnection is with a portion of the Otter Tail delivery system that is regulated, then the applicant shall be capable of tolerating steady-state voltage fluctuations of ± 5 percent of the normal voltage level, unless otherwise stated in the appropriate state rules.

For interconnections to the transmission system (generally above 12.5 kV), voltage levels ± 10 percent from normal can be expected. If the applicant's equipment cannot operate within the range shown in Table 3, the applicant may need to provide regulation equipment to limit voltage level excursions.

Table 3 – Voltage Limit on the Otter Tail System

	Low Voltage Limit	High Voltage Limit
Normal Operating Conditions[1]	0.97 p.u.	1.07 p.u.
Abnormal Operating Condition[2]	0.92 p.u.	1.10 p.u.
Transient Condition[3]	0.70 p.u.	1.20 p.u.

[1] Normal Operating Conditions are characterized by all Facilities being in–service during day-to-day operations of the System. High voltage limit of 1.05 p.u. is used on 230 and 345 kV lines.
[2] Abnormal Operating Conditions are characterized by the steady state operatig conditions following a system event, such as loss of a transmission line, substation, load, or generator.
[3] Transient Conditions are characterized by the short timeframe (ms) in which there is a system event occurring, such as loss of a transmission line, substation, load, generator, or a planned switching event on the transmission system. Wahpeton substation has special transient criteria of 0.80 p.u. to 1.18 p.u.

Consistent with the system performance criteria and technical study guidelines, the Otter Tail System is designed to avoid experiencing transient voltage dips below 0.70 pu due to external faults or other disturbance initiators. The applicant should allow sufficient dead band in its voltage regulation equipment control to avoid reacting to transient voltage dips.

If the design of the applicant's Facility is such that islanded conditions are possible, appropriate zero sequence sources must also be provided. The usual customer voltage concern refers to line-line values, but generation installed on distribution lines must also control the line-ground voltage during an islanded condition.

B. MINIMUM POWER FACTOR REQUIREMENTS

The applicant will generally be expected to provide for its own reactive power requirements.

Some portions of the Otter Tail power system are in or adjacent to areas where other power suppliers (Municipals or Co-ops) utilize "ripple" load management systems. These systems employ an on/off keyed carrier signal (typically in the range of 150-400 Hz) injected into the power systems to address applicant site load management devices. Installation of shunt capacitor banks, as may be required for power factor correction of induction machines, or for providing capacitive output capability, may cause degradation of the ripple signal strength due to shunting to ground of the ripple signal through the capacitor bank(s). To prevent such degradation, appropriate tuned blocking filters may be required.

1. Substation-Specific Power Factor Requirements

The Otter Tail Transmission System is designed and operated assuming the power factor at the transmission side of the distribution transformer is 90 percent when load is within 10 percent of the forecasted system minimum or maximum. Any interconnecting facility is expected to provide sufficient reactive power (leading or lagging) such that during these load periods the high side power factor does not fall below 90 percent.

If during normal operation (system intact or under transmission contingency conditions) the voltage in a portion of the Otter Tail System deviates from the voltage range described in Section X.A., Otter Tail will survey the interconnected substation(s) believed to be contributing to the voltage concern and the applicant may be asked to demonstrate, (either by metered values or by inventory of installed equipment) that the applicant meets its reactive power obligation. Any deviations are required to be corrected immediately.

2. Generator-Specific Power Factor Requirements

Generators connecting to the Otter Tail System will be expected to provide sufficient facilities and controls to operate their generation from 0.95 lead power factor to 0.95 lagging power factor at the Point of Interconnection. Generators interconnection that fall under the state jurisdictions may have different requirements.

The voltage set point that the generator needs to maintain will be established and adjusted as necessary by Otter Tail's System Operations Department. (This is necessary for all generation).

a. Reactive Supply and Voltage Control from Generation Sources Service – 10 MW or Larger

Reactive Supply and Voltage Control from Generation Sources Service is a FERC defined ancillary service. Any generator providing such service

to the Balancing Authority Area Operator must be able to automatically control the voltage level by adjusting the machine's power factor within a continuous range of between ± 95 percent power factor based on the station's sum total name plate generating capability. The only exception would be on an interconnection that falls under a state interconnection requirement.

The Voltage Control Response Rate (for synchronous generators, the exciter response ratio) is the speed with which the voltage-controlling device reacts to changes in the system voltage. The minimum response rate for a static excitation system shall have the exciter attain 95 percent of the exciter ceiling (maximum) voltage in 0.1 seconds. The exciter ceiling voltage shall be at least two times the exciter voltage at the rated full load value. For rotary exciters, the exciter response ratio shall be at least 2.0. The response ratio, ceiling voltage, and speed of response are defined in IEEE 421.2 1990.

Applicants choosing to provide Reactive Supply and Voltage Control from Generation Sources service must coordinate with existing voltage regulation devices. In most cases, this will be a concern for those generators connecting to voltage regulated distribution facilities (12.5 kV and below).

3. Generation Frequency / Speed Control

Please see Frequency / Speed Control in Section XVI.

4. Excitation Requirements

Please see Excitation Requirements in Section XVI.

XII. POWER QUALITY IMPACTS (R2.1.10)

A. FLICKER

Voltage fluctuations may be noticeable as visual lighting variations (flicker) and can damage or disrupt the operation of electronic equipment. Generators are not allowed to produce flicker that impacts adjacent customers and that exceeds IEEE 519 and IEEE 1453. Flicker could be caused from a variety of sources including (but not limited to) line switching, switched capacitor banks, load cycling, generator cut-ins or generator cut-outs, motor starting, etc…

Evaluation of a new or modified interconnection may involve a study to determine the reliability impacts on the Otter Tail System. This study may include an analysis of system response from switching certain Facilities could result in Flicker concerns. The study will typically include

system intact conditions (all facilities in-service) and contingency conditions (considering critical outages on the System) to determine how the performance of the System at the Point of Interconnection changes for different system conditions. The criteria to be used during the switching analysis include:

- The relative steady state voltage change is limited to 3 percent of the nominal voltage for system intact conditions; and
- The relative steady state voltage change is limited to 5 percent of the nominal voltage for simulations involving a contingency condition; whereas

The relative steady state voltage change is defined as the difference in voltage before and after a switching event.

Flicker tests for wind powered sources of generation shall be conducted in accordance with IEC 61000-4-15.

Applicants are not allowed to produce flicker to adjacent customers that exceeds the Otter Tail criteria stated above or within IEEE 519 or 1453. If flicker issues arise, Otter Tail will reference the applicable reference curves described in Table A.1 of IEEE 1453-2004 "Recommended Practice of Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems". The Applicant will be responsible and liable for corrections if the interconnection Facility is the cause of objectionable flicker levels. In the case where the Applicant owns a dedicated line so that other Otter Tail customers will be protected, a waiver of certain flicker requirements could be permitted.

B. HARMONICS

Harmonics can cause telecommunication interference, increase thermal heating in transformers, disable solid state equipment and create resonant overvoltages. In order to protect equipment from damage, harmonics must be managed and mitigated. The applicant's interconnecting equipment shall not introduce excessive distortion to the Otter Tail System's voltage and current waveforms per IEEE 519-1992.

The harmonic distortion is defined as the ratio of the root mean square (rms) value of the harmonic to the rms value of the fundamental voltage or current. The harmonic distortion measurements shall be made at the Point of Interconnection between the applicant and the Otter Tail System and shall be within the limits specified in the tables below. Otter Tail advises the applicant to account for harmonics during the early planning and design stages of any interconnection project. Refer to Tables 4 and 5 for voltage distortion limits.

Table 4. Voltage Distortion Limits

Bus Voltage At PCC	Individual Voltage Distortion IHD %	Total Voltage Distortion THD %
Below 69 kV	3.0	5.0
69 kV to 115 kV	1.5	2.5
115 kV and above	1.0	1.5
Source: IEEE 519, Table 11.1		

Table 5. Current Distortion Limits For Non-Linear Loads At The Point Of Common Coupling (PCC) From 120 To 69,000 Volts

Maximum Harmonic Current Distribution in % of Fundamental Harmonic Order (Odd Harmonics)						
I(sc)/I(l)	**<11**	**11<h<17**	**17<h<23**	**23<h<35**	**35<h**	**THD**
20	4.0	2.0	1.5	0.6	0.3	5.0
20-50	7.0	3.5	2.5	1.0	0.5	8.0
50-100	10.0	4.5	4.0	1.5	0.7	12.0
100-1000	12.0	5.5	5.0	2.0	1.0	15.0
1000	15.0	7.0	6.0	2.5	1.4	20.0

Where:
I(sc) = Maximum short circuit current at PCC
I(l) = Maximum load current (fundamental frequency) at PCC
PCC = Point of Common Coupling between applicant and utility

Generation equipment is subject to the lowest I(sc)/I(l) values
Even harmonics are limited to 25% of odd harmonic limits given above

Source: IEEE 519, Table 10.3

A special study will be required for situations when the fault to load ratio is less than 10.

Lower order harmonics, particularly the third and ninth harmonics, will often be of more concern to the applicant. These are often related to Facility grounding, and to the type of transformer connections that may be involved. It is to the applicant's advantage to work these problems out early enough so that applicant and Otter Tail equipment can be acquired to achieve proper control.

XIII. EQUIPMENT RATINGS (R2.1.11)

The Applicant and Otter Tail must work closely during the interconnection process. Upon Otter Tail acceptance of a valid interconnection application, the Applicant must provide sufficient information to Otter Tail about the expected equipment ratings (MW, MVAR, kV, Amps, etc.) in order to derive accurate modeling of the interconnection Facilities in any studies and/or evaluations.

Through the course of the interconnection process, Otter Tail shall provide the Facility Ratings Methodology (on file within Otter Tail) to the Applicant. The Applicant shall review the Otter Tail Facility Ratings Document to understand Otter Tail's methodology of determining the appropriate equipment ratings.

In determining the appropriate equipment ratings of Applicant-owned Facilities, the Applicant must consider manufacturer specifications of each piece of equipment since they are the basis for determining appropriate equipment ratings. Upon the Applicant's discretion and review of the Otter Tail facility ratings methodology, the Applicant shall provide Facility ratings to Otter Tail for the Applicant-owned equipment associated with the interconnection.

Otter Tail and the Applicant shall jointly review their respective equipment and determine the most limiting equipment associated with the interconnection. The most limiting equipment (whether owned by the Applicant or Otter Tail) shall dictate the overall rating of the interconnection equipment to be used in modeling for both real-time operations and planning studies.

All equipment needs to meet Otter Tail rating guidelines, which are established to meet NERC compliance. Equipment shall also meet applicable ANSI and/or IEEE standards

XIV. SYNCHRONIZING OF FACILITIES (R2.1.12)

A. SYNCHRONIZING RELAYS

Synchronous generators and other generators with stand-alone capability must use one of the following methods to synchronize with the Otter Tail System:

- Automatic synchronization with **automatic synchronizing relay** (Device 25) to synchronize with the Otter Tail System. The automatic synchronizing relay must have all of the following characteristics:
    - Slip frequency matching window of 0.1 Hz or less.
    - Voltage matching window of ±10 percent or less.
    - Phase angle acceptance window of ± 10 degrees or less.
    - Breaker closure time compensation.

Note: The automatic synchronizing relay sends a close signal to the breaker after the above conditions are met.

- Automatic synchronization with **automatic synchronizer** (Device 15/25) to synchronize with the Otter Tail System. The automatic synchronizer must have all of the following characteristics:
    - Slip frequency matching window of 0.1 Hz or less.
    - Voltage matching window of ±10 percent or less.
    - Phase angle acceptance window of ± 10 degrees or less.
    - Breaker closure time compensation. For an automatic synchronizer that does not have this feature, a tighter frequency window (± 5 degrees) with a one-second time acceptance window shall be used to achieve synchronization within ± 10 degrees phase angle.

Note: The automatic synchronizer has the ability to adjust generator voltage and frequency automatically to match system voltage and frequency, in addition to having the above characteristics.

- Manual synchronization with synchroscope and synch-check relay (Device 25) supervision. The synch-check relay must have the following characteristics:
    - Voltage matching window of ±10 percent or less.
    - Phase angle acceptance window of ± 10 degrees or less.

Generators with greater than 1,000 kW aggregate nameplate rating must have automatic synchronizing relay or automatic synchronizer.

XV. MAINTENANCE COORDINATION (R2.1.13)

Interconnection protective devices owned by the applicant (as determined by the interconnection study process) should be maintained and inspected according to manufacturer recommendations and/or industry standards. Procedures must be established for visual and operational inspections. Additionally, provisions should be established for equipment maintenance and testing. Equipment should include, but not be limited to:

- Circuit Breakers
- Protective Relays
- Control Batteries/Chargers
- P-Ts, Fuses, Switches, SCADA Equipment
- Metering

Otter Tail maintains the right to review maintenance, calibration and operation data of all protective equipment for the purpose of protecting Otter Tail facilities and other Otter Tail customers. The applicant is responsible for providing the necessary test accessories (such as relay test plugs, instruction manuals, wiring diagrams, etc.) required to allow testing of protective devices. Verification may include the tripping of the intertie breaker.

If Otter Tail performs work on the applicant's premises, an inspection of the work area may be made by Otter Tail. If hazardous working conditions are detected, the applicant will be required to correct the unsafe conditions before Otter Tail will perform the work.

XVI. OPERATIONAL ISSUES (R2.1.14)

At OTP's discretion, the applicant will supply, at its expense, an operating study and any required operating guides completed in coordination with Otter Tail, MISO , the Applicable Reliability Council, and impacted transmission operators and balancing authorities. This would be required before energiztion of the Facility and must be updated as required. This operating study may result in operating guides.

A. OPERATING GUIDELINES

The applicant shall operate its equipment within the guidelines of this handbook and any special requirements set forth by executed agreements with Otter Tail. Where there is conflict or inconsistency with the terms of the agreement(s) and this handbook, the terms in the agreement(s) shall apply.

Otter Tail reserves the right to open the intertie circuit breaker or disconnect device for any of the following reasons:

- Otter Tail is performing hot line maintenance work on the Otter Tail System.
- Otter Tail System emergency.
- Inspection of the applicant's equipment and protective equipment reveals a hazardous condition.
- Failure of the applicant to provide maintenance and testing reports when required.
- The applicant's equipment interferes with other customers or with the operation of the Otter Tail System.
- The applicant has modified the equipment or protective devices without the knowledge or approval of Otter Tail.
- Operation, by applicant, of any unapproved interconnection equipment.
- Personnel safety is threatened.
- Failure of the applicant to comply with applicable OSHA Safety Tagging and Lockout requirements as well as MISO, Applicable Reliability Council, and Otter Tail switching guides and safety standards or any successor agency assuming or charged with similar responsibilities.

The failure of Otter Tail to open the intertie circuit breaker or disconnect device shall not serve to relieve the applicant of any liability for injury, death or damage attributable to the negligence of the applicant.

Changes to the Otter Tail System, or the addition of other customers with generation in the vicinity, may require modifications to the interconnection protective devices. If such changes are required, the applicant may be subject to future charges for these modifications.

Operating criteria have been defined for applicant Facilities interconnecting with the Otter Tail System in order to minimize adverse operating conditions to customers on the Otter Tail System. The interconnection technical requirements are outlined in this section and where applicable, requirements specific to size and/or type of interconnection are noted.

B. FAULT CURRENT

The combined available fault current of the Otter Tail System and the applicant's facilities must not overstress Otter Tail equipment. The applicant shall provide any necessary provisions to satisfy this requirement. Except in unique circumstances, the designed maximum available fault current on the Otter Tail System depends upon the voltage level, as shown in the following table:

Voltage	Maximum Available Fault
4.16 kV	36 MVA
12.5 kV	108 MVA
41.6 kV	360 MVA
115 kV and greater	site specific

Protective equipment on the Otter Tail System is specified within these limits. If the installation of applicant-owned equipment causes these fault current limits to be exceeded, the applicant must install equipment to limit the fault current on the Otter Tail delivery system or compensate Otter Tail for the additional costs of installing equipment that will safely operate within the available fault current. The exact value of available fault current depends upon location and circuit configuration and will be determined during the interconnection process. The applicant must work closely with Otter Tail during the interconnection process to determine the available fault current at the specific location of interconnection.

C. FREQUENCY DURING DISTURBANCES

Power system disturbances initiated by system events such as faults and forced equipment outages expose the system to oscillations in voltage and frequency. It is important that generators and lines remain in service for dynamic (transient) oscillations that are stable and damped.

To avoid large-scale blackouts that can result from excessive generation loss, major transmission loss, or load loss during a disturbance, underfrequency load shedding has been implemented by Otter Tail in accordance with requirements set forth by the Applicable Reliability Council. When system frequency declines, loads are automatically interrupted in steps. Load shedding is

implemented it balance the generation and load. It is important that generators and lines remain connected to the system during frequency declines, both to limit the amount of load shedding required and to help the system avoid a complete collapse.

Additional voltage and frequency protection requirements for generators are found in Section VII.

D. GENERATOR FREQUENCY/SPEED CONTROL

1. 10 MW or Less

All applicant generating equipment shall be designed to operate between 59.5 and 60.5 hertz. The operating frequency of the applicant's generating equipment shall not deviate more than 0.5 hertz from a 60-hertz base.

For the detection of an island condition, generators must have a means of automatically disconnecting from the Otter Tail System within 0.2 seconds if the frequency cannot be maintained within 0.5 hertz.

2. 10MW or Greater

The applicant will operate its generator consistent with Otter Tail guidelines and requirements concerning frequency control. Generators shall be equipped with governors that sense frequency (unless exempt under NERC, MISO, or Applicable Reliability Council rules due to prime mover or regulatory limitations).

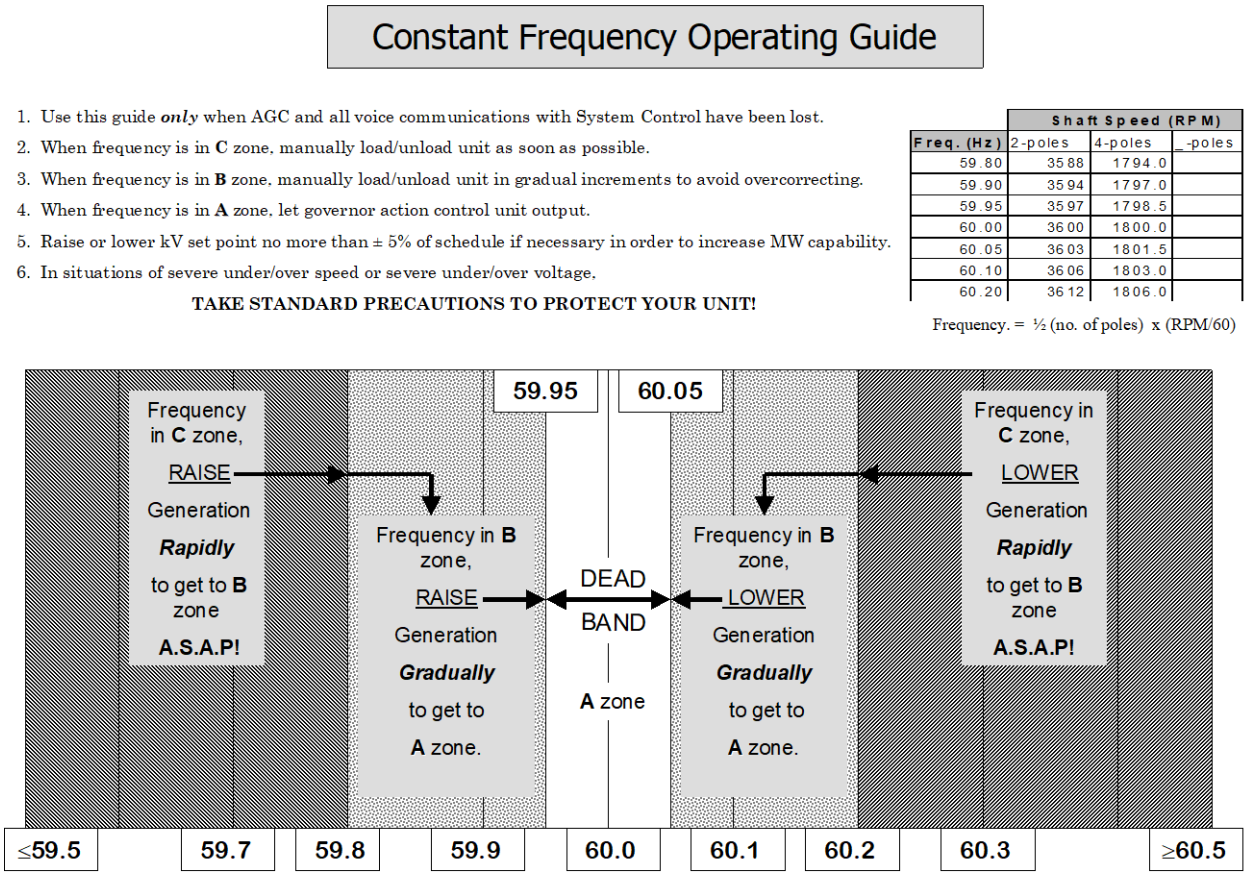
i. Applicant generating equipment must have short-term capability for non-islanded low frequency operation not less than the following:
   - 60.0 – 59.5 hertz continuous
   - 59.5 – 59.3 hertz 10 minutes
   - 59.3 – 58.7 hertz 10 seconds

   Frequency relays must not constrain the operation of the generating facility to less than these values, unless agreed to by Otter Tail. The frequency relays must also be coordinated with Otter Tail and the Applicable Reliability Council or MISO Under-Frequency Load Shed Plan. To ensure "ride-through" capability of the Otter Tail System, the applicant shall implement an under-frequency relay set point for the Facility no greater than 58.5 Hz.

ii. Unless Otter Tail agrees otherwise, if the generator is operated in parallel with Otter Tail's distribution System, the generator will provide appropriate relaying to detect an island condition and provide a means to automatically disconnect from the Otter Tail system within 0.2 seconds if the frequency cannot be maintained within 0.5 hertz.

iii. Frequency control when communications with the System Control Center has been lost; the Constant Frequency Operating Guide (below) shows the operation expected from all plant operators during major frequency excursions. The operator will respond following this guide to the maximum ability of the applicant's generating equipment.

Figure 6. Constant Frequency Operating Guide



3. Excitation System Requirements

An excitation system is required to regulate generator output voltage.

- Static systems shall have a minimum ceiling voltage of 150 percent of rated full load field voltage with 70 percent of generator terminal voltage and a maximum response time of two cycles (0.033 seconds).
- Rotating systems shall have an ANSI voltage response ratio of 2.0 or faster.
- Excitation systems shall respond to system disturbances equally in both the buck and boost directions.

Under certain conditions, Otter Tail may grant an exemption for generation Facilities that have excitation systems not meeting these requirements

XVII. INSPECTION REQUIREMENTS FOR EXISTING OR NEW FACILITIES (R2.1.15)

A. INSPECTION, TEST, CALIBRATION AND MAINTENANCE

The applicant has full responsibility for the inspection, testing, calibration and maintenance of their facilities, up to the Point of Interconnection, consistent with the Interconnection and Operating Agreement.

1. Pre-energization Inspection and Testing

Before initial energization, the applicant shall develop an Inspection and Test Plan for pre-energization and energization testing. Otter Tail will review and approve the test plan prior to the test. Any costs incurred by Otter Tail as a result of the inspection and testing will be passed through to the applicant. The applicant will also be responsible for any additional tests that may be required by Otter Tail but were not specified in the applicant's Inspection and Test Plan. The applicant shall provide Otter Tail with copies of all drawings, specifications, and test records of the interconnection equipment and pertinent to the interconnected operation for Otter Tail's records.

The applicant must have the interconnection installation inspected and certified by a qualified technician or a certified electrical state inspector for proper installation and operation of the interconnection protective devices. The inspection shall include, *but not be limited to*:

- Verification that the installation is in accordance with the study results from the interconnection study process.
- Verification of the proper operation of the protective schemes.

- Verification that the proper voltages and currents are applied to the interconnection protective relays.
- Verification of proper operation and settings of the interconnection protective relays.
- Verification of synchronizing equipment.
- Trip testing of the breaker(s) tripped by the interconnection relays.

2. Calibration and Maintenance

a. Metering Equipment

Upon installation of, and at applicant's expense, Otter Tail or applicant shall have the right to inspect and test all metering equipment. Thereafter, the meter testing frequency shall, at a minimum, be based on industry accepted practices and guidelines outlined in ANSI C12.1. Otter Tail's present testing practices are based on the type of metering situation and the jointly agreed-to requirements of both parties involved. Typically, the metering equipment at non-Otter Tail generation/interconnection sites is tested every three years. If requested to do so by applicant, Otter Tail shall inspect or test metering equipment more frequently than every three years, at the expense of the applicant. Any current or potential transformers that are used for metering will adhere to the "Accuracy Classifications for Metering" listed in ANSI C57.13.

b. All Other Electrical Equipment

The applicant shall maintain its Facilities and equipment, to the extent they might reasonably be expected to have an impact on the operation of the Otter Tail System: (1) in a safe and reliable manner; (2) in accordance with Good Utility Practice; (3) in accordance with applicable operational and/or reliability criteria, protocols, and directives, including those of NERC, the MISO, Applicable Reliability Council, state or any successor agency assuming or charged with similar responsibilities; and (4) in accordance with the provisions of the Interconnection and Operating Agreement and any attachment, appendix or exhibit thereof.

XVIII. COMMUNICATIONS AND PROCEDURES DURING NORMAL AND EMERGENCY OPERATING CONDITIONS (R2.1.16)

Prior to operation of any new interconnection (generation, tie-line or substation), the Applicant must provide contact information to Otter Tail for the NERC certified operator of the Facilities.

This contact information will serve as a means to establish communications between Otter Tail and the operator of the new interconnection during normal and emergency operating conditions. Furthermore, the applicant will be required to arrange for a Meter Data Management Agent (MDMA). The Applicant may choose to utilize Otter Tail to perform this responsibility, which would require an MDMA agreement. At a minimum, the applicant shall at least inform Otter Tail how this is being handled if Otter Tail is not the MDMA. Maintenance of the facilities is to be coordingated with Otter Tail.

The applicant shall also arrange to get real-time SCADA data to the MISO according to the MISO protocols and data compatibility requirements. The applicant may choose to utilize Otter Tail to perform this responsibility, which would be addressed in the CASOT.

A. DISPATCHING AND MAINTENANCE

Otter Tail operates and maintains its system to provide reliable customer service while meeting the seasonal and daily peak loads even during equipment outages and disturbances. Project integration requires that the equipment at the Point of Interconnection not restrict timely outage coordination, automatic switching or equipment maintenance scheduling. Preserving reliable service to all Otter Tail customers is essential and may require additional switchgear, equipment redundancy, or bypass capabilities at the Point of Interconnection for acceptable operation of the System.

1. Emergency Response Requirement

   The substation applicant must agree to follow any load sheding directives by Otter Tail and corrdination of load restoration with Otter Tail.

   The tie-line applicant must make its facilities available to otter Tail during emergencies as far as physically possible.

   The generation applicant must agree to make its generation available for call by Otter Tail for MISO emergencies. Unless the generator is out for maintenance or due to mechanical failure, the applicant must be able to bring the unit to full output within the time specified in the emergency offer to the MISO. This capability must be available throughout the season in which the unit is planned to operate. *This requirement is not required for installations less than 100 KW.* Failure to respond in a timely manner may result in financial penalties if such financial penalties are assessed by MISO and/or the Applicable Reliability Council.

The generator will be expected to supply up to maximum available reactive capability and/or to adjust generation levels including reducing to zero if requested by the System Operator. This will usually be for reliability purposes.

XIX. MISCELLANEOUS

A. STATION SERVICE

Power that is provided for local use at a substation to operate lighting, heat and auxiliary equipment is termed station service. Alternate station service is a backup source of power, used only in emergencies or during maintenance when primary station service is not available.

Station service power is the responsibility of the applicant. The station service requirements of the new Facilities, including voltage and reactive requirements, shall not impose operating restrictions on the Otter Tail System beyond those specified in applicable NERC, MISO, and Applicable Reliability Council reliability criteria.

Appropriate provisions for station service and alternate station service will be determined during the interconnection process. Generally, the local utility will be the preference provider of primary station service unless it is unable to serve the load or costs to connect to the local utility are prohibitive.

The applicant must provide metering for station service and alternate station service, as specified by the metering section of this handbook, or work out other acceptable arrangements.

B. ANCILLARY SERVICES

The applicant is required to obtain or provide for ancillary services (or portions of such services as required by FERC or NERC) for any electric load served from the interconnected electric grid. The MISO provides ancillary servicesfor the Otter Tail System.

The applicant will be required to sign a Service Agreement under Otter Tail's CASOT, which will specify which ancillary services the applicant is required to take and/or make provisions for. Otter Tail will then determine the telemetering, controls, and metering that will be required to integrate the load or Facility into the Local Balancing Authority Area and in order to effectuate provision of the required ancillary services.

Ancillary services are also required for such an event where the applicant's generation unit may trip off-line requiring Otter Tail to provide for the applicant's loss of generation. Therefore, any generation applicant operating in long term parallel configuration to the Otter Tail System to serve its own electric load must provide for the reserve capacity requirements, operating (spinning) and non-spinning reserve, reserved load regulating capability, unit cycling capability to satisfy NERC Control Performance Criteria, have the ability to determine actual after-the-fact load and generation, and have the delivery system capacity to receive emergency power. While it is expected that the applicant will obtain all such services from the MISO, the applicant must confirm with Otter Tail, as applicable, that it is in compliance at all times with these requirements.

C. SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) REQUIREMENTS

SCADA indication of real and reactive power flows and voltage levels is required. If the connection is made directly to another utility's transmission system, SCADA control and status indication requirements shall be jointly determined. SCADA control and status indication of the power circuit breakers and associated isolating switches used to connect with Otter Tail may be required. SCADA control of breakers and isolating switches that are located at other than the Point of Interconnection is not normally required, although status indication may be necessary.

All substations with a circuit breaker rated at 41.6 kV or greater and all generation 5 MW or greater shall provide SCADA for the circuit breaker to the Balancing Authority Area. The following equipment data and status must be provided in a 6 second or less periodicity to the Balancing Authority Area:

- Breaker position
- Motor operated disconnect position
- Transmission line flow and alarming
- Bus voltage and alarming battery and associated equipment status
- Protective relaying AC and DC voltage status
- Protective relay communication channel status
- Transformer and associated equipment status
- Lockout relay status
- Capacitor/reactor status
- Other points as necessary to provide control and indication

XX. PRE-PARALLEL CONTRACT REQUIREMENTS

Prior to the actual operation of applicant-owned Facilities interconnected with the Otter Tail System, all equipment modifications must be complete and applicable contracts signed. Applicants may be required to sign the "Interconnection and Operating Agreement." All facilities or entities scheduling within, in, or out of the Otter Tail's Balancing Authority Area are required to sign a Control Area Services and Operations Tariff. The CASOT addresses such things as scheduling, system control, and dispatch service; reactive supply and voltage control from generation sources; operating reserves; load regulation and frequency response; generator regulation and frequency response; load following; load imbalance; generator imbalance; generator backup supply; dynamic scheduling and short-interval scheduling. The applicant must enter into a Control Area Services and Operations Tariff with the Company no later than 60 days prior to synchronization.

Otter Tail may, at its option, witness the inspection. The applicant must give Otter Tail not less than seventy-two (72) hours prior written notice of upcoming tests. The certification and test report will be furnished to both the applicant and Otter Tail as soon as practical.

Upon performance and certification of the pre-parallel inspection and execution of appropriate contracts/agreements, the applicant shall be granted approval for operation of the Interconnection Facility and equipment in parallel with the Otter Tail System. Neither the inspection nor the granting of approval to the applicant shall relieve the applicant of any liability for injury, death or damage attributable to the negligence of the applicant. The inspection and approval by Otter Tail does not constitute a warranty or relieve the applicant of responsibility for the operating condition or installation of the equipment and may not be relied upon by the applicant for that purpose.

Once the Facility is interconnected, Otter Tail will retain the right to inspect the Facility if the operation is suspected of causing problems for other Otter Tail customers, and Otter Tail retains the right to inspect at its discretion.

XXI. GLOSSARY

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.

Apparent Power: For single phase, the current in amperes multiplied by the volts equals the apparent power in volt-amperes. This term is used for alternating current circuits because the current flow is not always in phase with the voltage; hence, amperes multiplied by volts does not necessarily give the true power or watts. Apparent power for three-phase equals the phase to neutral volts multiplied by ampere multiplied by 3.

Applicable Reliability Regional Council Entity: The NERC Regional Entity, or its successor, in which the Facility is located.

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.

Balancing Authority Area: A area balancing authority area is an electrical system bound by interconnect (tie- line) metering and telemetry and regulating its generation in order to maintain its interchange schedule with other systems, contributes to frequency regulation of the Interconnection and fulfills its obligations and responsibilities in accordance with NERC and reliability region requirements.

Balancing Authority Area Load: Balancing Authority Area Load is the entire demand for energy within a specified Balancing Authority Area.

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

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: The Distributed Generation is synchronized with Otter Tail Power prior to the transfer occurring. The transfer switch then parallels with Otter Tail Power for a short time (100 msec. Or less) and then the Generation System and load is disconnect from Otter Tail Power. This transfer is less disruptive than the Quick Open Transition because it allows the Distributed Generation a brief time to pick up the load before the support of Otter Tail Power is lost. With this type of transfer, the load is always being supplied by Otter Tail Power or the Distributed Generation.

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.

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.

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 Otter Tail power system operator. The adjustment includes capability to start-up and shut down generating units.

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.

EMS: Energy Management System. The computer system Otter Tail uses to provide real-time status and remote control of its electrical transmission system.

Facility: The applicant's electric generating, tie-line, or substation facility identified generally in the Generator Interconnection Agreement and more specifically identified in the "as built" drawings provided to the Company in accordance with Section 9.4 of the Generator Interconnection Agreement, together with the other property, facilities, and equipment owned and/or controlled by the applicant on the applicant's side of the Points of Interconnection.

FERC: Federal Energy Regulatory Commission. FERC is an independent body within the Department of Energy (DOE) regulating interstate transmission, prices of electricity and natural

gas. It also licenses hydroelectric projects, interconnections, construction work in progress, rates for wholesale customers, and utility accounting practices and procedures.

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 that is inserted in a circuit for the purpose of opening the circuit when the current reaches a certain value.

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.

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

Incoming Breaker: The applicant-owned breaker that connects Otter Tail source of power to the applicant's bus.

Interconnection: The physical system of electrical transmission between the applicant's Facility and the utility.

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

Inverter Connection: This is a continuous parallel connection with the system. Small Generation Systems may utilize inverters to interface to Otter Tail Power. Solar, wind and fuel cells are some examples of Generation which typically use inverters to connect to Otter Tail Power. The design of such inverters shall either contain all necessary protection to prevent unintentional islanding, or the Interconnection Customer shall install conventional protection to affect the same protection. All required protective elements for a soft-loading transfer switch apply to an inverter connection.

Island: A part of an interconnected system that 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.

Isolated: In this scheme, the generating unit will supply all of the needs of the connected load.

Kilovolt (kV): One thousand volts.

Kilovolt-Ampere (kVA): One thousand volt amperes. See the definition for Apparent Power.

Kilowatt (kW): An electric unit of power that equals 1,000 watts.

Kilowatthour (kWh): One thousand watts of power supplied for one hour. A basic unit of electric energy equal to the use of 1 kilowatt for a period of one hour.

Lagging Power Factor: Occurs when reactive power flows in the same direction as real power.

Leading Power Factor: Occurs when reactive power flows in the opposite direction of real power.

Line Losses: Electrical energy converted to heat in the resistance of all transmission and/or distribution lines and other electrical equipment.

Local Balancing Authority: The entity responsible to NERC for compliance with the subset of NERC Balancing Authority Reliability Standards defined in the Balancing Authority Agreement for its Local Balancing Authority Area within the MISO Balancing Authority Area

Local Balancing Authority Area: The collection of generation, transmission, and loads within the metered boundaries of the Local Balancing Authority.

NERC: North American Electric Reliability Council. A national organization responsible for establishing the operating and planning standards to assure the reliability of the electric grid.

Non-Spinning Reserve: All unloaded generating capability not meeting the Spinning Reserve criteria that can be made fully effective in 10 minutes. This may include generation that shall be made available within 10 minutes by interrupting or curtailing loads or changing schedules.

Ohm: The practical unit of electrical impedance equal to the resistance of a circuit in which a potential difference of 1 volt produces a current of 1 ampere.

Open Transition: With this transfer switch, the load to be supplied from the Distributed Generation is first disconnected from Otter Tail Power and then connected to the Generation. This transfer can be relatively quick, but voltage and frequency excursions are to be expected during transfer. Computer equipment and other sensitive equipment will shut down and reset. The transfer switch typically consists of a standard UL approved transfer switch with mechanical interlocks between the two source contactors that drop Otter Tail Power source before the Distributed Generation is connected to supply the load.

Operating Reserve: The sum of Spinning and Non-Spinning Reserve.

Otter Tail Power System: This consists of Transmission, Distribution, and Generator tie-lines owned by Otter Tail Power Company.

Parallel Operation: The operation of an applicant-owned generator while connected to the utility's grid. Parallel operation may be required solely for the applicant's operating convenience or for the purpose of delivering power to the utility's grid.

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

Point of Interconnection: The point or points where the facilities of the applicant interconnect with the facilities of Otter Tail (point of ownership change).

Power: Actual, Active or Real Power. The time rate of transferring or transforming energy or the power that accomplishes work. Measured in Watts.

Power Factor: The ratio of actual power (kW) to apparent power (kVA).

Power Flow: One-way power flow is the condition where the flow of power is entirely into the applicant's Facility.

Two-way power flow is the condition where the net flow of power may be either into or out of the applicant's Facility depending on the operation of the generator and other customer load.

Power System Stabilizer: Supplemental excitation device for dampening low-frequency oscillations.

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.

Quick Open Transition: The load to be supplied from the Distributed Generation is first disconnected from Otter Tail Power and then connected to the Distributed Generation, similar to the open transition. However, this transition is typically much faster (under 500 ms) than the conventional open transition transfer operation. Voltage and frequency excursions will still occur, but some computer equipment and other sensitive equipment will typically not be affected with a properly designed system. The transfer switch consists of a standard UL approved transfer switch, with mechanical interlocaks between the two source contacts that drop Otter Tail Power source before the Distributed Generation is connected to supply the load.

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.

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.

Self-Service Generators: Generators operated in parallel with the Otter Tail System only for the purpose of reducing the applicant's peak load. These generators are not normally dispatchable by Otter Tail.

Soft Loading: *With Limited Parallel -* The Distributed Generation is paralleled with Otter Tail Power for a limited amount of time (generally less than 1-2 minutes) to gradually transfer the

load from Otter Tail Power to the Generation system. This minimizes the voltage and frequency problems, by softly loading and unloading the Generation System.

With Extended Parallel - The Generation System is paralleled with Otter Tail Power in continuous operation. Special deisgn, coordination and agreements are required before any extended parallel operation will be permitted. Otter Tail Power interconnection study will identify the issues involved.

Spinning Reserve: The amount of unloaded generating capability of a participant connected to and synchronized with the interconnected system of the participants and ready to take load. Spinning Reserve allocation to any generator shall not exceed the amount of generation increase that can be realized in 10 minutes. (Change to NERC?)

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: The entire generating, transmitting and distributing facilities of an electric company.

System Control Center: Systems and System Operators used in the coordination and deployment activities required to support the safe and reliable operation of interconnected systems.

System Operator: A person authorized to operate or supervise the operation of the interconnected systems within the Balancing Authority Area.

Tariff: The Control Area Services and Operations Tariff of Otter Tail Power Company or the MISO tariff.

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 Provider: Entity providing transmission service to the Customer that agrees to purchase Local Balancing Authority Services under the Service Agreement. For transmission service over Company's transmission facilities, that entity shall be MISO.

Transmission Provider's Tariff: The open access transmission tariff of the Transmission Provider on file with FERC, as it may be amended or superseded, under which unbundled retail transmission service is provided on the Transmission Provider's Transmission System, or the equivalent transmission and ancillary service rates or tariffs established by non-jurisdictional Transmission Providers

Voltage: Electric potential or potential difference expressed in volts.

Volt-Ampere: A unit of apparent power in an alternating-current circuit.

VAr: Volt ampere reactive, see Reactive Power.

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

Wheeling: The use of transmission facilities of one utility system to transmit power to another utility system, or between customer facilities within a single utility system or between systems.

Wholesale Generator: A generator operated in parallel with the Otter Tail System and that provides power and energy for Otter Tail's purchase or for use by another Applicable Reliability Council member or non-member and/or where the Otter Tail System is utilized for delivery.

Wye or "Y" Connected Circuit (Star Connected): A three-phase circuit in which windings of all three phases have one common connection.

XIII. REFERENCES

American National Standard Code for Electricity Metering, ANSI/IEEE C12.1-1995.

Electric Power Systems And Equipment - Voltage Ratings (60 Hz), ANSI C84.1-1995 (R2001).

IEC Electromagnetic Compatibility (EMC) – Part 3: Limits – Section 7: Assessment of Emission Limits for Fluctuating Loads in MV and HV Power Systems, CEI/IEC 1000-3-7:1996.

IEC Electromagnetic Compatibility (EMC) – Part 4: Testing and Measurement Techniques, CEI/IEC 61000-4-15:1997.

IEEE Draft Standard for Distributed Resources Interconnected with Electric Power Systems, IEEE P1547 (draft 6 12/22/00). **Please Note:** Once this draft has been approved, the approved version will replace this draft.

IEEE Guide for Identification, Testing, and Evaluation of the Dynamic Performance of Excitation Control Systems, IEEE 421.2-1990.

IEEE Guide for Protective Relaying of Utility - Consumer Interconnections, IEEE C37.95-2000.

IEEE Guide for the Protection of Network Transformers, ANSI C37.108-1989 (R1994).

IEEE Guide for Safety in Substation Grouping, IEEE 80-2000.

IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, IEEE Standard 519-1992.

IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications - Orange Book, ANSI/IEEE Std. 446-1995.

IEEE Recommended Practice for Monitoring Electric Power Quality, IEEE Std. 1159-1995.

IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book, ANSI/IEEE Std. 242-1986 (R1991).

IEEE Standard for Distributed Resources Interconnected with Electric Power Systems, IEEE P1547 (DRAFT).

IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus, ANSI/IEEE C37.90-1989 (R1994).

IEEE Standard Requirements for Instrument Transformers, IEEE C57.13-1993.

IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems, ANSI/IEEE C37.90.1-1989 (R1994).

IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers, ANSI/IEEE C37.90.2-1995.

IEEE Surge Voltages In Low-Voltage AC Power Circuits, IEEE C62.41-1991 (R1995).

Integrated Non-Utility Generation, North American Electric Reliability Council, Princeton, NJ 08540, April 1992.

MAPP Reliability Manual, Mid-Continent Area Power Pool – or the Reliability Manual of MISO, Applicable Reliability Council, or its successor.

NERC Planning Standards, North American Electric Reliability Council.

NERC Operating Manual, North American Electric Reliability Council.

National Electrical Code, NFPA 70, National Fire Protection Association, Quincy, MA 02269, 1999 Edition.

National Electrical Safety Code, ANSI C2-1997, Institute of Electrical and Electronics Engineers, Inc.

OSHA Safety Tagging and Lock-out Procedures.

Appendix A: Interconnetion Data Submittal

For Interconnection to Otter Tail Power Company System

WHO SHOULD FILE THIS SUBMITTAL: Anyone requesting interconnection to Otter Tail Power System that does not supply this information through some other formal process. This submittal shall be completed and provided to Otter Tail Power's Interconnection Coordinator.

INFORMATION: This submittal is used to document the interconnection formal process. The Applicant shall complete as much of the form as applicable. The Applicant will be contacted if additional information is required.

Transmission-Transmission & Transmission-Load Interconnection Request Form

Project Name:	OTP Queue No.

Section I. Requestor Information			
Contact Name:			
Title:			
Company:			
Address:			
City, State, Zip:			
Phone:		Cell Phone:	
E-Mail Address:			
Date of Request:		In-service Date:	
Type of Interconnection Requested:	☐ Transmission-Transmission	☐ Transmission-Load	

Section II. Project Information			
Briefly describe your project: *Attach a site drawing and proposed one-line diagram.*			
Location of Proposed Connection			
State:		County:	
Township Name (if applicable):	Section:	Township:	Range:
OTP Transmission Line Name, Number, and Structure Number (if known):			
Substation (if applicable):			
Will additional rights of way (ROW) or easements be required? Yes ☐ No ☐			
Who will obtain?			

Section III. Equipment Requirements		
Customer Interconnecting Equipment		
Voltage	Ampacity	Conductor Size
Quantity	Shield Wire Size	Transformer Size
Type of Protection		
Connecting Equipment (Switches)		
Voltage	Amperage	Remote Control ? Yes ☐ No ☐
Type of Switch Operation:	Manual ☐ Hydraulic ☐	Electric Motor ☐
Comments:		

Section IV. Metering Requirements			
Is Metering Required? Yes ☐ No ☐			
Check Any That Apply:			
Pool Tie Metering ☐	Load Metering ☐	Line Loss Compensation ☐	Transformer Loss Compensation ☐
Describe Any Special Communications or SCADA Requirements:			

Section V. Load Information	
Expected Load:	Power Factor:
Load Characteristics:	

Section VI. Miscellaneous
Please reference any related documents, e.g. one-line diagrams, scope of work, appendixes, etc...

Section VII. Contact Information			
Customer Project Manager			
Name:			
Title:			
Address:			
City, State, Zip:			
Phone:		Cell Phone	
E-Mail Address:			
Customer Transmission Manager			
Name:			
Title:			
Address:			
City, State, Zip:			
Phone:		Cell Phone	
E-Mail Address:			
Customer Contract Contact			
Name:			
Title:			
Address:			
City, State, Zip:			
Phone:		Cell Phone:	
E-Mail Address:			
Customer Operations/Maintenance Contact			
Name:			
Title:			
Address:			
City, State, Zip:			
Phone:		Cell Phone:	
E-Mail Address:			

APPLICANT	
Signature_____	Date _____

SEND COMPLETED AND SIGNED INTERCONNECT REQUEST FORM ALONG WITH ONE-LINE AND SITE DRAWING TO OTTER TAIL POWER COMPANY'S INTERCONNECTION COORDINATOR AT THE FOLLOWING ADDRESS:

Dean Pawlowski
Otter Tail Power Company
215 S Cascade Street
Fergus Falls, MN 56537
dpawlowski@otpco.com

Appendix B: MN Distributed Generation Requirements

STATE OF MINNESOTA

DISTRIBUTED GENERATION INTERCONNECTION REQUIREMENTS

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Interconnection requirements

Foreword

Electric distribution system connected generation units span a wide range of sizes and electrical characteristics. Electrical distribution system design varies widely from that required to serve the rural customer to that needed to serve the large commercial customer. With so many variations possible, it becomes complex and difficult to create one interconnection standard that fits all generation interconnection situations.

In establishing a generation interconnection standard there are three main issues that must be addressed; Safety, Economics and Reliability.

The first and most important issue is safety; the safety of the general public and of the employees working on the electrical systems. This standard establishes the technical requirements that must be met to ensure the safety of the general public and of the employees working with Otter Tail Power. Typically designing the interconnection system for the safety of the general public will also provide protection for the interconnected equipment.

The second issue is economics; the interconnection design must be affordable to build. The interconnection standard must be developed so that only those items, that are necessary to meet safety and reliability, are included in the requirements. This standard sets the benchmark for the minimum required equipment. If it is not needed, it will not be required.

The third issue is reliability; the generation system must be designed and interconnected such that the reliability and the service quality for all customers of the electrical power systems are not compromised. This applies to all electrical systems not just Otter Tail Power.

Many generation interconnection standards exist or are in draft form. The IEEE, FERC and many states have been working on generation interconnection standards. There are other standards such as the National Electrical Code (NEC) that, establish requirements for electrical installations. The NEC requirements are in addition to this standard. This standard is designed to document the requirements where the NEC has left the establishment of the standard to "the authority having jurisdiction" or to cover issues which are not covered in other national standards.

This standard covers installations, with an aggregated capacity of 10MW's or less. Many of the requirements in this document do not apply to small, 40kW or less generation installations. As an aid to the small, distributed generation customer, these small unit interconnection requirements have been extracted from this full standard and are available as a separate, simplified document titled: "Standards for Interconnecting Generation Sources, Rated Less then 40kW with Minnesota Electric Utilities"

Interconnection requirements

1. Introduction

This standard has been developed to document the technical requirements for the interconnection between a Generation System and an area electrical power system "Utility system or Area EPS", here Otter Tail Power. This standard covers 3 phase Generation Systems with an aggregate capacity of 10 MW's or less and single phase Generation Systems with a aggregate capacity of 40kW or less at the Point of Common Coupling. This standard covers Generation Systems that are interconnected with Otter Tail Power's distribution facilities. This standard does not cover Generation Systems that are directly interconnected with Otter Tail Power's Transmission System, Contact Otter Tail Power for their Transmission System interconnection standards.

While, this standard provides the technical requirements for interconnecting a Generation System with a typical radial distribution system, it is important to note that there are some unique Area EPS, which have special interconnection needs. One example of a unique Area EPS would be one operated as a "networked" system. This standard does not cover the additional special requirements of those systems. The Interconnection Customer must contact the Owner/operator of Otter Tail Power with which the interconnection is intended, to make sure that the Generation System is not proposed to be interconnected with a unique Area EPS. If the planned interconnection is with a unique Area EPS, the Interconnection Customer must obtain the additional requirements for interconnecting with Otter Tail Power.

Otter Tail Power has the right to limit the maximum size of any Generation System or number of Generation Systems that, may want to interconnect, if the Generation System would reduce the reliability to the other customers connected to Otter Tail Power.

This standard only covers the technical requirements and does not cover the interconnection process from the planning of a project through approval and construction. Please read the companion document "State of Minnesota Interconnection Process for Distributed Generation Systems" for the description of the procedure to follow and a generic version of the forms to submit. It is important to also get copies of Otter Tail Power's tariff's concerning generation interconnection which will include rates, costs and standard interconnection agreements. The earlier the Interconnection Customer gets Otter Tail Power involved in the planning and design of the Generation System interconnection the smoother the process will go.

Interconnection requirements

A) Definitions

The definitions defined in the "IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems" (1547 Draft Ver. 11) apply to this document as well. The following definitions are in addition to the ones defined in IEEE 1547 , or are repeated from the IEEE 1547 standard.

i) "Area EPS" an electric power system (EPS) that serves Local EPS's. Note. Typically, an Area EPS has primary access to public rights-of-way, priority crossing of property boundaries, etc. Otter Tail Power's distribution system is an AREA EPS.

ii) "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.

iii) "Generation System" the interconnected Distributed Generation(s), controls, relays, switches, breakers, transformers, inverters and associated wiring and cables, up to the Point of Common Coupling.

iv) "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.

v) "Local EPS" an electric power system (EPS) contained entirely within a single premises or group of premises.

vi) "Point of Common Coupling" the point where the Local EPS is connected to Otter Tail Power.

vii) "Transmission System", are those facilities as defined by using the guidelines established by the Minnesota State Public Utilities Commission; "In the Matter of Developing Statewide Jurisdictional Boundary Guidelines for Functionally Separating Interstate Transmission from Generation and Local Distribution Functions" Docket No. E-015/M-99-1002.

viii) "Type-Certified" Generation paralleling equipment that is listed by an OSHA listed national testing laboratory as having met the applicable type testing requirement of UL 1741. At the time is document was prepared this was the only national standard available for certification of generation transfer switch equipment. This definition does not preclude other forms of type-certification if agreeable to Otter Tail Power.

B) Interconnection Requirements Goals

This standard defines the minimum technical requirements for the implementation of the electrical interconnection between the Generation System and Otter Tail Power. It does not define the overall requirements for the Generation System. The requirements in this standard are intended to achieve the following:

i) Ensure the safety of utility personnel and contractors working on the electrical power system.

ii) Ensure the safety of utility customers and the general public.

iii) Protect and minimize the possible damage to the electrical power system and other customer's property.

iv) Ensure proper operation to minimize adverse operating conditions on the electrical power

system.

C) Protection

The Generation System and Point of Common Coupling shall be designed with proper protective devices to promptly and automatically disconnect the Generation from Otter Tail Power in the event of a fault or other system abnormality. The type of protection required will be determined by:

i) Size and type of the generating equipment.

ii) The method of connecting and disconnecting the Generation System from the electrical power system.

iii) The location of generating equipment on Otter Tail Power.

D) Otter Tail Power Modifications

Depending upon the match between the Generation System, Otter Tail Power and how the Generation System is operated, certain modifications and/or additions may be required to the existing Otter Tail Power with the addition of the Generation System. To the extent possible, this standard describes the modifications which could be necessary to Otter Tail Power for different types of Generation Systems. For some unique interconnections, additional and/or different protective devices, system modifications and/or additions will be required by Otter Tail Power; In these cases Otter Tail Power will provide the final determination of the required modifications and/or additions. If any special requirements are necessary they will be identified by Otter Tail Power during the application review process.

E) Generation System Protection

The Interconnection Customer is solely responsible for providing protection for the Generation System. Protection systems required in this standard, are structured to protect Otter Tail Power's electrical power system and the public. The Generation System Protection is not provided for in this standard. Additional protection equipment may be required to ensure proper operation for the Generation System. This is especially true while operating disconnected, from Otter Tail Power. Otter Tail Power does not assume responsibility for protection of the Generation System equipment or of any portion Local EPS.

F) Electrical Code Compliance

Interconnection Customer shall be responsible for complying with all applicable local, independent, state and federal codes such as building codes, National Electric Code (NEC), National Electrical Safety Code (NESC) and noise and emissions standards. As required by Minnesota State law, Otter Tail Power will require proof of complying with the National Electrical Code before the interconnection is made, through installation approval by an electrical inspector recognized by the Minnesota State Board of Electricity.

The Interconnection Customer's Generation System and installation shall comply with latest revisions of the ANSI/IEEE standards applicable to the installation, especially IEEE 1547; "Standard for Interconnecting Distributed Resources with Electric Power Systems". See the reference section in this document for a partial list of the standards which apply to the generation installations covered by this standard.

Interconnection requirements

2. References

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

IEEE Std 100-2000, "IEEE Standard Dictionary of Electrical and Electronic Terms"

IEEE Std 519-1992, "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems"

IEEE Std 929-2000,"IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems".

IEEE Std 1547, "IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems"

IEEE Std C37.90.1-1989 (1995), "IEEE Standard Surge Withstand Capability (SEC) Tests for Protective Relays and Relay Systems".

IEEE Std C37.90.2 (1995), "IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers".

IEEE Std C62.41.2-2002, "IEEE Recommended Practice on Characterization of Surges in Low Voltage (1000V and Less) AC Power Circuits"

IEEE Std C62.42-1992 (2002), "IEEE Recommended Practice on Surge Testing for Equipment Connected to Low Voltage (1000V and less) AC Power Circuits"

ANSI C84.1-1995,"Electric Power Systems and Equipment – Voltage Ratings (60 Hertz)"

ANSI/IEEE 446-1995, "Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications".

ANSI/IEEE Standard 142-1991, "IEEE Recommended Practice for Grounding of Industrial an Commercial Power Systems – Green Book",

UL Std. 1741 "Inverters, Converters, and Controllers for use in Independent Power Systems"

NEC – "National Electrical Code", National Fire Protection Association (NFPA), NFPA-70-2002.

NESC – "National Electrical Safety Code". ANSI C2-2000, Published by the Institute of Electrical and Electronics Engineers, Inc.

Interconnection requirements

3. Types of Interconnections

A) The manner in which the Generation System is connected to and disconnected from Otter Tail Power can vary. Most transfer systems normally operate using one of the following five methods of transferring the load from Otter Tail Power to the Generation System.

B) If a transfer system is installed which has a user accessible selection of several transfer modes, the transfer mode that has the greatest protection requirements will establish the protection requirements for that transfer system.

i) Open Transition (Break-Before-Make) Transfer Switch – With this transfer switch, the load to be supplied from the Distributed Generation is first disconnected from Otter Tail Power and then connected to the Generation. This transfer can be relatively quick, but voltage and frequency excursions are to be expected during transfer. Computer equipment and other sensitive equipment will shut down and reset. The transfer switch typically consists of a standard UL approved transfer switch with mechanical interlocks between the two source contactors that drop Otter Tail Power source before the Distributed Generation is connected to supply the load.

(1) To qualify as an Open Transition switch and the limited protective requirements, mechanical interlocks are required between the two source contacts. This is required to ensure that one of the contacts is always open and the Generation System is never operated in parallel with Otter Tail Power. If the mechanical interlock is not present, the protection requirements are as if the switch is a closed transition switch.

(2) As a practical point of application, this type of transfer switch is typically used for loads less then 500kW. This is due to possible voltage flicker problems created on Otter Tail Power, when the load is removed from or returned to Otter Tail Power source. Depending up Otter Tail Power's stiffness this level may be larger or smaller then the 500kW level.

(3) Figure 1 at the end of this document provides a typical one-line of this type of installation.

ii) Quick Open Transition (Break-Before-Make) Transfer Switch – The load to be supplied from the Distributed Generation is first disconnected from Otter Tail Power and then connected to the Distributed Generation, similar to the open transition. However, this transition is typically much faster (under 500 ms) than the conventional open transition transfer operation. Voltage and frequency excursions will still occur, but some computer equipment and other sensitive equipment will typically not be affected with a properly designed system. The transfer switch consists of a standard UL approved transfer switch, with mechanical interlocks between the two source contacts that drop Otter Tail Power source before the Distributed Generation is connected to supply the load.

(1) Mechanical interlocks are required between the two source contacts to ensure that one of the contacts is always open. If the mechanical interlock is not present, the protection requirements are as if the switch is a closed transition switch

(2) As a practical point of application this type of transfer switch is typically used for loads less then 500kW. This is due to possible voltage flicker problems created on Otter Tail Power, when the load is removed from or returned to Otter Tail Power source. Depending up Otter Tail Power's stiffness this level may be larger or smaller than the 500kW level.

(3) Figure 2 at the end of this document provides a typical one-line of this type of installation and shows the required protective elements.

iii) Closed Transition (Make-Before-Break) Transfer Switch – The Distributed Generation is synchronized with Otter Tail Power prior to the transfer occurring. The transfer switch then parallels with Otter Tail Power for a short time (100 msec. or less) and then the Generation System and load is disconnect from Otter Tail Power. This transfer is less disruptive than the Quick Open Transition because it allows the Distributed Generation a brief time to pick up the load before the support of Otter Tail Power is lost. With this type of transfer, the load is always being supplied by Otter Tail Power or the Distributed Generation.

(1) As a practical point of application this type of transfer switch is typically used for loads less then 500kW. This is due to possible voltage flicker problems created on Otter Tail Power, when the load is removed from or returned to Otter Tail Power source. Depending up Otter Tail Power's stiffness this level may be larger or smaller then the 500kW level.

(2) Figure 2 at the end of this document provides a typical one-line of this type of installation and shows the required protective elements. The closed transition switch must include a separate parallel time limit relay, which is not part of the generation control PLC and trips the generation from the system for a failure of the transfer switch and/or the transfer switch controls.

iv) Soft Loading Transfer Switch

(1) With Limited Parallel Operation – The Distributed Generation is paralleled with Otter Tail Power for a limited amount of time (generally less then 1-2 minutes) to gradually transfer the load from Otter Tail Power to the Generation System. This minimizes the voltage and frequency problems, by softly loading and unloading the Generation System.

(a) The maximum parallel operation shall be controlled, via a parallel timing limit relay (62PL). This parallel time limit relay shall be a separate relay and not part of the generation control PLC.

(b) Protective Relaying is required as described in section 6.

(c) Figure 3 at the end of this document provide typical one-line diagrams of this type of installation and show the required protective elements.

(2) With Extended Parallel Operation – The Generation System is paralleled with Otter Tail Power in continuous operation. Special design, coordination and agreements are required before any extended parallel operation will be permitted. Otter Tail Power interconnection study will identify the issues involved.

(a) Any anticipated use in the extended parallel mode requires special agreements and special protection coordination.

(b) Protective Relaying is required as described in section 6.

(c) Figure 4 at the end of this document provides a typical one-line for this type of interconnection. It must be emphasized that this is a typical installations only and final installations may vary from the examples shown due to transformer connections, breaker configuration, etc.

v) Inverter Connection

This is a continuous parallel connection with the system. Small Generation Systems may utilize inverters to interface to Otter Tail Power. Solar, wind and fuel cells are some examples of Generation which typically use inverters to connect to Otter Tail Power. The design of such inverters shall either contain all necessary protection to prevent unintentional islanding, or the Interconnection Customer shall install conventional protection to affect the same protection. All required protective elements for a soft-loading transfer switch apply to an inverter connection. Figure 5 at the end of this document, shows a typical inverter interconnection.

Interconnection requirements

(1) Inverter Certification – Prior to installation, the inverter shall be Type-Certified for interconnection to the electrical power system. The certification will confirm its anti-islanding protection and power quality related levels at the Point of Common Coupling. Also, utility compatibility, electric shock hazard and fire safety are approved through UL listing of the model. Once this Type Certification is completed for that specific model, additional design review of the inverter should not be necessary by Otter Tail Power.

(2) For three-phase operation, the inverter control must also be able to detect and separate for the loss of one phase. Larger inverters will still require custom protection settings, which must be calculated and designed to be compatible with the specific Area EPS (i.e. Otter Tail Power) being interconnected with.

(3) A visible disconnect is required for safely isolating the Distributed Generation when connecting with an inverter. The inverter shall not be used as a safety isolation device.

(4) When banks of inverter systems are installed at one location, a design review by Otter Tail Power must be preformed to determine any additional protection systems, metering or other needs. The issues will be identified by Otter Tail Power during the interconnection study process

Interconnection requirements

4. Interconnection Issues and Technical Requirements

A) General Requirements - The following requirements apply to all interconnected generating equipment. Otter Tail Power shall be the source side and the customer's system shall be the load side in the following interconnection requirements.

i) Visible Disconnect - A disconnecting device shall be installed to electrically isolate Otter Tail Power from the Generation System. The only exception for the installation of a visible disconnect is if the generation is interconnected via a mechanically interlocked open transfer switch and installed per the NEC (702.6) "so as to prevent the inadvertent interconnection of normal and alternate sources of supply in any operation of the transfer equipment."

The visible disconnect shall provide a visible air gap between Interconnection Customer's Generation and Otter Tail Power in order to establish the safety isolation required for work on Otter Tail Power's distribution system. This disconnecting device shall be readily accessible 24 hours per day by Otter Tail Power field personnel and shall be capable of padlocking by Otter Tail Power field personnel. The disconnecting device shall be lockable in the open position.

The visible disconnect shall be a UL approved or National Electrical Manufacture's Association approved, manual safety disconnect switch of adequate ampere capacity. The visible disconnect shall not open the neutral when the switch is open. A draw-out type circuit breaker can be used as a visual open.

The visible disconnect shall be labeled, as required by Otter Tail Power to inform Otter Tail Power field personnel.

ii) Energization of Equipment by Generation System – The Generation System shall not energize a de-energized Otter Tail Power's distribution system. The Interconnection Customer shall install the necessary padlocking (lockable) devices on equipment to prevent the energization of a de-energized electrical power system. Lock out relays shall automatically block the closing of breakers or transfer switches on to a de-energized Otter Tail Power's distribution system.

iii) Power Factor - The power factor of the Generation System and connected load shall be as follows;

(1) Inverter Based interconnections – shall operate at a power factor of no less then 90%.at the inverter terminals.

(2) Limited Parallel Generation Systems, such as closed transfer or soft-loading transfer systems shall operate at a power factor of no less then 90%, during the period when the Generation System is parallel with Otter Tail Power, as measured at the Point of Common Coupling.

(3) Extended Parallel Generation Systems shall be designed to be capable of operating between 90% lagging and 95% leading. These Generation Systems shall normally operate near unity power factor (+/-98%) or as mutually agreed between Otter Tail Power and the Interconnection Customer.

iv) Grounding Issues

(1) Grounding of sufficient size to handle the maximum available ground fault current 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.

(2) It is the responsibility of the Interconnection Customer 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"

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

v) Sales to Otter Tail Power or other parties – Transportation of energy on the Transmission system is regulated by the area reliability council and FERC. Those contractual requirements are not included in this standard. Otter Tail Power will provide these additional contractual requirements during the interconnection approval process.

B) For Inverter based, closed transfer and soft loading interconnections - The following additional requirements apply:

i) Fault and Line Clearing - The Generation System shall be removed from Otter Tail Power for any faults, or outages occurring on the electrical circuit serving the Generation System

ii) Operating Limits in order to minimize objectionable and adverse operating conditions on the electric service provided to other customers connected to Otter Tail Power, the Generation System shall meet the Voltage, Frequency, Harmonic and Flicker operating criteria as defined in the IEEE 1547 standard during periods when the Generation System is operated in parallel with Otter Tail Power.

If the Generation System creates voltage changes greater than 4% on Otter Tail Power, it is the responsibility of the Interconnection Customer to correct these voltage sag/swell problems caused by the operation of the Generation System. If the operation of the interconnected Generation System causes flicker, which causes problems for others customer's interconnected to Otter Tail Power, the Interconnection Customer is responsible for correcting the problem.

iii) Flicker - The operation of Generation System is not allowed to produce excessive flicker to adjacent customers. See the IEEE 1547 standard for a more complete discussion on this requirement.

The stiffer Otter Tail Power, the larger a block load change that it will be able to handle. For any of the transfer systems Otter Tail Power voltage shall not drop or rise greater than 4% when the load is added or removed from Otter Tail Power. It is important to note, that if another interconnected customer complains about the voltage change caused by the Generation System, even if the voltage change is below the 4% level, it is the Interconnection Customer's responsibility to correct or pay for correcting the problem. Utility experience has shown that customers have seldom objected to instantaneous voltage changes of less then 2% on Otter Tail Power's distribution system, so most Otter Tail Power operators use a 2% design criteria

iv) Interference - The Interconnection Customer shall disconnect the Distributed Generation from Otter Tail Power if the Distributed Generation causes radio, television or electrical service interference to other customers, via the EPS or interference with the operation of Otter Tail Power's distribution system. The Interconnection Customer shall either effect repairs to the Generation System or reimburse Otter Tail Power Operator for the cost of any required Otter Tail Power modifications due to the interference.

v) Synchronization of Customer Generation-

(1) An automatic synchronizer with synch-check relaying is required for unattended automatic quick open transition, closed transition or soft loading transfer systems.

(2) To prevent unnecessary voltage fluctuations on Otter Tail Power, it is required that the synchronizing equipment be capable of closing the Distributed Generation into Otter Tail Power within the limits defined in IEEE 1547 . Actual settings shall be determined by the Registered Professional Engineer establishing the protective settings for the installation.

(3) Unintended Islanding – Under certain conditions with extended parallel operation, it would be possible for a part of Otter Tail Power to be disconnected from the rest of Otter Tail Power and have the Generation System continue to operate and provide power to a portion of the isolated circuit. This condition is called "islanding". It is not possible to successfully reconnect the energized isolated circuit to the rest of Otter Tail Power since there are no synchronizing controls associated with all of the possible locations of disconnection. Therefore, it is a requirement that the Generation System be automatically disconnected from Otter Tail Power immediately by protective relays for any condition that would cause Otter Tail Power to be de-energized. The Generation System must either isolate with the customer's load or trip. The Generation System must also be blocked from closing back into Otter Tail Power until Otter Tail Power is reenergized and Otter Tail Power voltage is within Range B of ANSI C84.1 Table 1 for a minimum of 1 minute. Depending upon the size of the Generation System it may be necessary to install direct transfer trip equipment from Otter Tail Power source(s) to remotely trip the generation interconnection to prevent islanding for certain conditions

vi) Disconnection – Otter Tail Power operator may refuse to connect or may disconnect a Generation System from Otter Tail Power under the following conditions:

(1) Lack of approved Standard Application Form and Standard Interconnection Agreement.

(2) Termination of interconnection by mutual agreement.

(3) Non-Compliance with the technical or contractual requirements.

(4) System Emergency or for imminent danger to the public or Otter Tail Power personnel (Safety).

(5) Routine maintenance, repairs and modifications to Otter Tail Power. Otter Tail Power operator shall coordinate planned outages with the Interconnection Customer to the extent possible.

Interconnection requirements

5. Generation Metering, Monitoring and Control

Metering, Monitoring and Control – Depending upon the method of interconnection and the size of the Generation System, there are different metering, monitoring and control requirements Table 5A is a table summarizing the metering, monitoring and control requirements..

Due to the variation in Generation Systems and Otter Tail Power operational needs, the requirements for metering, monitoring and control listed in this document are the expected maximum requirements that Otter Tail Power will apply to the Generation System. It is important to note that for some Generation System installations Otter Tail Power may wave some of the requirements of this section if they are not needed. An example of this is with rural or low capacity feeders which require more monitoring then larger capacity, typically urban feeders.

Another factor which will effect the metering, monitoring and control requirements will be the tariff under which the Interconnection Customer is supplied by Otter Tail Power. Table 5A has been written to cover most application, but some Otter Tail Power tariffs may have greater or less metering, monitoring and control requirements then, as shown in Table 5A. .

Interconnection requirements

TABLE 5A Metering, Monitoring and Control Requirements			
Generation System Capacity at Point of Common Coupling	**Metering**	**Generation Remote Monitoring**	**Generation Remote Control**
< 40 kW with all sales to Otter Tail Power	Bi-Directional metering at the point of common coupling	None Required	None Required
< 40 kW with Sales to a party other then Otter Tail Power	Recording metering on the Generation System and a separate recording meter on the load	Interconnection Customer supplied direct dial phone line.	None Required
40 – 250kW with limited parallel	Detented Otter Tail Power Metering at the Point of Common Coupling	None Required	None Required
40 – 250kW with extended parallel	Recording metering on the Generation System and a separate recording meter on the load	Interconnection Customer supplied direct dial phone line. Otter Tail Power to supply it's own monitoring equipment	None Required
250 – 1000 kW with limited parallel	Detented Otter Tail Power Metering at the Point of Common Coupling	Interconnection Customer supplied direct dial phone line and monitoring points available. See B (i)	None Required
250 – 1000 kW With extended parallel operation	Recording metering on the Generation System and a separate recording meter on the load.	Required Otter Tail Power remote monitoring system See B (i)	None Required
>1000 kW With limited parallel Operation	Detented Otter Tail Power Metering at the Point of Common Coupling	Required Otter Tail Power SCADA monitoring system. See B (i)	None required
>1000 kW With extended parallel operation	Recording metering on the Generation System and a separate recording meter on the load.	Required Otter Tail Power SCADA monitoring system See B (i)	Direct Control via SCADA by Otter Tail Power of interface breaker.

"Detented" = A meter which is detented will record power flow in only one direction.

Interconnection requirements

A) Metering

i) As shown in Table 5A the requirements for metering will depend up on the type of generation and the type of interconnection. For most installations, the requirement is a single point of metering at the Point of Common Coupling. Otter Tail Power Operator will install a special meter that is capable of measuring and recording energy flow in both directions, for three phase installations or two detented meters wired in series, for single phase installations.. A dedicated - direct dial phone line may be required to be supplied to the meter for Otter Tail Power's use to read the metering. Some monitoring may be done through the meter and the dedicated – direct dial phone line, so in many installations the remote monitoring and the meter reading can be done using the same dial-up phone line.

ii) Depending upon which tariff the Generation System and/or customer's load is being supplied under, additional metering requirements may result. Contact Otter Tail Power for tariff requirements. In some cases, the direct dial-phone line requirement may be waived by Otter Tail Power for smaller Generation Systems.

iii) All Otter Tail Power's revenue meters shall be supplied, owned and maintained by Otter Tail Power. All voltage transformers (VT) and current transformers (CT), used for revenue metering shall be approved and/or supplied by Otter Tail Power. Otter Tail Power's standard practices for instrument transformer location and wiring shall be followed for the revenue metering.

iv) For Generation Systems that sell power and are greater then 40kW in size, separate metering of the generation and of the load is required. A single meter recording the power flow at the Point of Common Coupling for both the Generation and the load, is not allowed by the rules under which the area transmission system is operated. Otter Tail Power is required to report to the regional reliability council (MAPP) the total peak load requirements and is also required to own or have contracted for, accredited generation capacity of 115% of the experienced peak load level for each month of the year. Failure to meet this requirement results in a large monetary penalty for Otter Tail Power operator.

v) For Generation Systems which are less then 40kW in rated capacity and are qualified facilities under PURPA (Public Utilities Regulatory Power Act – Federal Gov. 1978), net metering is allowed and provides the generation system the ability to back feed Otter Tail Power at some times and bank that energy for use at other times. Some of the qualified facilities under PURPA are solar, wind, hydro, and biomass. For these net-metered installations, Otter Tail Power may use a single meter to record the bi-directional flow or Otter Tail Power Operator may elect to use two detented meters, each one to record the flow of energy in one direction.

B) Monitoring (SCADA) is required as shown in table 5A. The need for monitoring is based on the need of the system control center to have the information necessary for the reliable operation of Otter Tail Power's. This remote monitoring is especially important during periods of abnormal and emergency operation.

The difference in Table 5A between remote monitoring and SCADA is that SCADA typically is a system that is in continuous communication with a central computer and provides updated values and status, to Otter Tail Power operator, within several seconds of the changes in the field. Remote monitoring on the other hand will tend to provide updated values and status within minutes of the change in state of the field. Remote monitoring is typically less expensive to install and operate.

i) Where Remote Monitoring or SCADA is required, as shown in Table 5A, the following monitored and control points are required:

(1) Real and reactive power flow for each Generation System (kW and kVAR). Only required if separate metering of the Generation and the load is required, otherwise #4 monitored at

Interconnection requirements

A) Metering

i) As shown in Table 5A the requirements for metering will depend up on the type of generation and the type of interconnection. For most installations, the requirement is a single point of metering at the Point of Common Coupling. Otter Tail Power Operator will install a special meter that is capable of measuring and recording energy flow in both directions, for three phase installations or two detented meters wired in series, for single phase installations.. A dedicated - direct dial phone line may be required to be supplied to the meter for Otter Tail Power's use to read the metering. Some monitoring may be done through the meter and the dedicated – direct dial phone line, so in many installations the remote monitoring and the meter reading can be done using the same dial-up phone line.

ii) Depending upon which tariff the Generation System and/or customer's load is being supplied under, additional metering requirements may result. Contact Otter Tail Power for tariff requirements. In some cases, the direct dial-phone line requirement may be waived by Otter Tail Power for smaller Generation Systems.

iii) All Otter Tail Power's revenue meters shall be supplied, owned and maintained by Otter Tail Power. All voltage transformers (VT) and current transformers (CT), used for revenue metering shall be approved and/or supplied by Otter Tail Power. Otter Tail Power's standard practices for instrument transformer location and wiring shall be followed for the revenue metering.

iv) For Generation Systems that sell power and are greater then 40kW in size, separate metering of the generation and of the load is required. A single meter recording the power flow at the Point of Common Coupling for both the Generation and the load, is not allowed by the rules under which the area transmission system is operated. Otter Tail Power is required to report to the regional reliability council (MAPP) the total peak load requirements and is also required to own or have contracted for, accredited generation capacity of 115% of the experienced peak load level for each month of the year. Failure to meet this requirement results in a large monetary penalty for Otter Tail Power operator.

v) For Generation Systems which are less then 40kW in rated capacity and are qualified facilities under PURPA (Public Utilities Regulatory Power Act – Federal Gov. 1978), net metering is allowed and provides the generation system the ability to back feed Otter Tail Power at some times and bank that energy for use at other times. Some of the qualified facilities under PURPA are solar, wind, hydro, and biomass. For these net-metered installations, Otter Tail Power may use a single meter to record the bi-directional flow or Otter Tail Power Operator may elect to use two detented meters, each one to record the flow of energy in one direction.

B) Monitoring (SCADA) is required as shown in table 5A. The need for monitoring is based on the need of the system control center to have the information necessary for the reliable operation of Otter Tail Power's. This remote monitoring is especially important during periods of abnormal and emergency operation.

The difference in Table 5A between remote monitoring and SCADA is that SCADA typically is a system that is in continuous communication with a central computer and provides updated values and status, to Otter Tail Power operator, within several seconds of the changes in the field. Remote monitoring on the other hand will tend to provide updated values and status within minutes of the change in state of the field. Remote monitoring is typically less expensive to install and operate.

i) Where Remote Monitoring or SCADA is required, as shown in Table 5A, the following monitored and control points are required:

(1) Real and reactive power flow for each Generation System (kW and kVAR). Only required if separate metering of the Generation and the load is required, otherwise #4 monitored at

the point of Common Coupling will meet the requirements.

(2) Phase voltage representative of Otter Tail Power's service to the facility.

(3) Status (open/close) of Distributed Generation and interconnection breaker(s) or if transfer switch is used, status of transfer switch(s).

(4) Customer load from Otter Tail Power service (kW and kVAR).

(5) Control of interconnection breaker - if required by Otter Tail Power operator.

When telemetry is required, the Interconnection Customer must provide the communications medium to Otter Tail Power's Control Center. This could be radio, dedicated phone circuit or other form of communication. If a telephone circuit is used, the Interconnection Customer must also provide the telephone circuit protection. The Interconnection Customer shall coordinate the RTU (remote terminal unit) addition with Otter Tail Power. Otter Tail Power may require a specific RTU and/or protocol to match their SCADA or remote monitoring system.

Interconnection requirements

6. Protective Devices and Systems

A) Protective devices required to permit safe and proper operation of Otter Tail Power while interconnected with customer's Generation System are shown in the figures at the end of this document. In general, an increased degree of protection is required for increased Distributed Generation size. This is due to the greater magnitude of short circuit currents and the potential impact to system stability from these installations. Medium and large installations require more sensitive and faster protection to minimize damage and ensure safety.

If a transfer system is installed which has a user accessible selection of several transfer modes, the transfer mode which has the greatest protection requirements will establish the protection requirements for that transfer system.

The Interconnection Customer shall provide protective devices and systems to detect the Voltage, Frequency, Harmonic and Flicker levels as defined in the IEEE 1547 standard during periods when the Generation System is operated in parallel with Otter Tail Power. The Interconnection Customer shall be responsible for the purchase, installation, and maintenance of these devices. Discussion on the requirements for these protective devices and systems follows:

i) Relay settings

(1) If the Generation System is utilizing a Type-Certified system, such as a UL listed inverter a Professional Electrical Engineer is not required to review and approve the design of the interconnecting system. If the Generation System interconnecting device is not Type-Certified or if the Type-Certified Generation System interconnecting device has additional design modifications made, the Generation System control, the protective system, and the interconnecting device(s) shall be reviewed and approved by a Professional Electrical Engineer, registered in the State of Minnesota.

(2) A copy of the proposed protective relay settings shall be supplied to Otter Tail Power operator for review and approval, to ensure proper coordination between the generation system and Otter Tail Power.

ii) Relays

(1) All equipment providing relaying functions shall meet or exceed ANSI/IEEE Standards for protective relays, i.e., C37.90, C37.90.1 and C37.90.2.

(2) Required relays that are not "draw-out" cased relays shall have test plugs or test switches installed to permit field testing and maintenance of the relay without unwiring or disassembling the equipment. Inverter based protection is excluded from this requirement for Generation Systems <40kW at the Point of Common Coupling.

(3) Three phase interconnections shall utilize three phase power relays, which monitor all three phases of voltage and current, unless so noted in the appendix one-lines.

(4) All relays shall be equipped with setting limit ranges at least as wide as specified in IEEE 1547 , and meet other requirements as specified in Otter Tail Power interconnect study. 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 .

(a) Over-current relays (IEEE Device 50/51 or 50/51V) shall operate to trip the protecting breaker at a level to ensure protection of the equipment and at a speed to allow proper coordination with other protective devices. For example, the over-current

relay monitoring the interconnection breaker shall operate fast enough for a fault on the customer's equipment, so that no protective devices will operate on Otter Tail Power. 51V is a voltage restrained or controlled over-current relay and may be required to provide proper coordination with Otter Tail Power.

(b) Over-voltage relays (IEEE Device 59) shall operate to trip the Distributed Generation per the requirements of IEEE 1547 .

(c) Under-voltage relays (IEEE Device 27) shall operate to trip the Distributed Generation per the requirements of IEEE 1547

(d) Over-frequency relays (IEEE Device 81O) shall operate to trip the Distributed Generation off-line per the requirements of IEEE 1547 .

(e) Under-frequency relay (IEEE Device 81U) shall operate to trip the Distributed Generation off-line per the requirements of IEEE 1547 . For Generation Systems with an aggregate capacity greater then 30kW, the Distribution Generation shall trip off-line when the frequency drops below 57.0-59.8 Hz. typically this is set at 59.5 Hz, with a trip time of 0.16 seconds, but coordination with Otter Tail Power is required for this setting.

Otter Tail Power will provide the reference frequency of 60 Hz. The Distributed Generation control system must be used to match this reference. The protective relaying in the interconnection system will be expected to maintain the frequency of the output of the Generation.

(f) Reverse power relays (IEEE Device 32) (power flowing from the Generation System to Otter Tail Power) shall operate to trip the Distributed Generation off-line for a power flow to the system with a maximum time delay of 2.0 seconds.

(g) Lockout Relay (IEEE Device 86) is a mechanically locking device which is wired into the close circuit of a breaker or switch and when tripped will prevent any close signal from closing that device. This relay requires that a person manually resets the lockout relay before that device can be reclosed. These relays are used to ensure that a denergized system is not reenergized by automatic control action, and prevents a failed control from auto-reclosing an open breaker or switch.

(h) Transfer Trip – All Generation Systems are required to disconnect from Otter Tail Power when Otter Tail Power is disconnected from its source, to avoid unintentional islanding. With larger Generation Systems, which remain in parallel with Otter Tail Power, a transfer trip system may be required to sense the loss of Otter Tail Power source. When Otter Tail Power source is lost, a signal is sent to the Generation System to separate the Generation from Otter Tail Power. The size of the Generation System vs the capacity and minimum loading on the feeder will dictate the need for transfer trip installation. Otter Tail Power interconnection study will identify the specific requirements.

If multiple Otter Tail Power sources are available or multiple points of sectionalizing on Otter Tail Power, then more then one transfer trip system may be required. Otter Tail Power interconnection study will identify the specific requirements. For some installations the alternate Otter Tail Power source(s) may not be utilized except in rare occasions. If this is the situation, the Interconnection Customer may elect to have the Generation System locked out when the alternate source(s) are utilized, if agreeable to Otter Tail Power operator.

(i) Parallel limit timing relay (IEEE Device 62PL) set at a maximum of 120 seconds for soft transfer installations and set no longer then 100ms for quick transfer installations,

shall trip the Distributed Generation circuit breaker on limited parallel interconnection systems. Power for the 62 PL relay must be independent of the transfer switch control power. The 62PL timing must be an independent device from the transfer control and shall not be part of the generation PLC or other control system.

TABLE 6A
SUMMARY OF RELAYING REQUIREMENTS

Type of Interconnection	Over-current (50/51)	Voltage (27/59)	Frequency (81 0/U)	Reverse Power (32)	Lockout (86)	Parallel Limit Timer	Sync-Check (25)	Transfer Trip
Open Transition Mechanically Interlocked (Fig. 1)	—	—	—	—	—	—	—	—
Quick Open Transition Mechanically Interlocked (Fig. 2)	—	—	—	—	Yes	Yes	Yes	—
Closed Transition (Fig. 2)	—	—	—	—	Yes	Yes	Yes	—
Soft Loading Limited Parallel Operation (Fig. 3)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—
Soft Loading Extended Parallel < 250 kW (Fig. 4)	Yes	Yes	Yes	—	Yes	—	Yes	—
Soft Loading Extended Parallel >250kW (Fig.4)	Yes	Yes	Yes	—	Yes	—	Yes	Yes
Inverter Connection (Fig. 5)								
< 40 kW	Yes	Yes	Yes	—	Yes	—	—	—
40 kW – 250kW	Yes	Yes	Yes	—	Yes	—	—	—
> 250 kW	Yes	Yes	Yes	—	Yes	—	—	Yes

Interconnection requirements

7. Agreements

A) Interconnection Agreement – This agreement is required for all Generation Systems that parallel with Otter Tail Power. Each of Otter Tail Power's tariffs contain standard interconnection agreements. There are different interconnection agreements depending upon the size and type of Generation System. This agreement contains the terms and conditions upon which the Generation System is to be connected, constructed and maintained, when operated in parallel with Otter Tail Power. Some of the issues covered in the interconnection agreement are as follows;

i) Construction Process

ii) Testing Requirements

iii) Maintenance Requirements

iv) Firm Operating Requirements such as Power Factor

v) Access requirements for Otter Tail Power personnel

vi) Disconnection of the Generation System (Emergency and Non-emergency)

vii) Term of Agreement

viii) Insurance Requirements

ix) Dispute Resolution Procedures

B) Operating Agreement – For Generation Systems that normally operate in parallel with Otter Tail Power, an agreement separate from the interconnection agreement, called the "operating agreement", is usually created. This agreement is created for the benefit of both the Interconnection Customer and Otter Tail Power operator and will be agreed to between the Parties. This agreement will be dynamic and is intended to be updated and reviewed annually. For some smaller systems, the operating agreement can simply be a letter agreement for larger and more intergraded Generation Systems the operating agreement will tend to be more involved and more formal. The operating agreement covers items that are necessary for the reliable operation of the Local and Otter Tail Power system. The items typically included in the operating agreement are as follows;

i) Emergency and normal contact information for both Otter Tail Power operations center and for the Interconnection Customer

ii) Procedures for periodic Generation System test runs.

iii) Procedures for maintenance on Otter Tail Power that effect the Generation System.

iv) Emergency Generation Operation Procedures

Interconnection requirements

8. Testing Requirements

A) Pre-Certification of equipment

The most important part of the process to interconnect generation with Local and Otter Tail Power's is safety. One of the key components of ensuring the safety of the public and employees is to ensure that the design and implementation of the elements connected to the electrical power system operate as required. To meet this goal, all of the electrical wiring in a business or residence, is required by the State of Minnesota to be listed by a recognized testing and certification laboratory, for its intended purpose. Typically we see this as "UL" listed. Since Generation Systems have tended to be uniquely designed for each installation they have been designed and approved by Professional Engineers. As the number of Generation Systems installed increase, vendors are working towards creating equipment packages which can be tested in the factory and then will only require limited field testing. This will allow us to move towards "plug and play" installations. For this reason, this standard recognizes the efficiency of "pre-certification" of Generation System equipment packages that will help streamline the design and installation process.

An equipment package shall be considered certified for interconnected operation if it has been submitted by a manufacture, tested and listed by a nationally recognized testing and certification laboratory (NRTL) for continuous utility interactive operation in compliance with the applicable codes and standards. Presently generation paralleling equipment that is listed by a nationally recognized testing laboratory as having met the applicable type-testing requirements of UL 1741 and IEEE 929, shall be acceptable for interconnection without additional protection system requirements. An "equipment package" shall include all interface components including switchgear, inverters, or other interface devices and may include an integrated generator or electric source. If the equipment package has been tested and listed as an integrated package which includes a generator or other electric source, it shall not required further design review, testing or additional equipment to meet the certification requirements for interconnection. If the equipment package includes only the interface components (switchgear, inverters, or other interface devices), then the Interconnection Customer shall show that the generator or other electric source being utilized with the equipment package is compatible with the equipment package and consistent with the testing and listing specified for the package. Provided the generator or electric source combined with the equipment package is consistent with the testing ad listing performed by the nationally recognized testing and certification laboratory, no further design review, testing or additional equipment shall be required to meet the certification requirements of this interconnection procedure. A certified equipment package does not include equipment provided by Otter Tail Power.

The use of Pre-Certified equipment does not automatically qualify the Interconnection Customer to be interconnected to Otter Tail Power. An application will still need to be submitted and an interconnection review may still need to be performed, to determine the compatibility of the Generation System with Otter Tail Power.

B) Pre-Commissioning Tests

i) Non-Certified Equipment

(1) Protective Relaying and Equipment Related to Islanding

(a) Distributed generation that is not Type-Certified (type tested), shall be equipped with protective hardware and/or software designed to prevent the Generation from being connected to a de-energized Otter Tail Power's distribution system.

(b) The Generation may not close into a de-energized Otter Tail Power distribution system and protection provided to prevent this from occurring. It is the

Interconnection Customer's responsibility to provide a final design and to install the protective measures required by Otter Tail Power. Otter Tail Power will review and approve the design, the types of relays specified, and the installation. Mutually agreed upon exceptions may at times be necessary and desirable. It is strongly recommended that the Interconnection Customer obtain Otter Tail Power written approval prior to ordering protective equipment for parallel operation. The Interconnection Customer will own these protective measures installed at their facility.

(c) The Interconnection Customer shall obtain prior approval from Otter Tail Power for any revisions to the specified relay calibrations.

C) Commissioning Testing

The following tests shall be completed by the Interconnection Customer. All of the required tests in each section shall be completed prior to moving on to the next section of tests. Otter Tail Power operator has the right to witness all field testing and to review all records prior to allowing the system to be made ready for normal operation Otter Tail Power shall be notified, with sufficient lead time to allow the opportunity for Otter Tail Power personnel to witness any or all of the testing.

i) Pre-testing The following tests are required to be completed on the Generation System prior to energization by the Generator or Otter Tail Power. Some of these tests may be completed in the factory if no additional wiring or connections were made to that component. These tests are marked with a "*"

(1) Grounding shall be verified to ensure that it complies with this standard, the NESC and the NEC.

(2) * CT's (Current Transformers) and VT's (Voltage Transformers) used for monitoring and protection, shall be tested to ensure correct polarity, ratio and wiring

(3) CT's shall be visually inspected to ensure that all grounding and shorting connections have been removed where required.

(4) Breaker / Switch tests – Verify that the breaker or switch cannot be operated with interlocks in place or that the breaker or switch cannot be automatically operated when in manual mode. Various Generation Systems have different interlocks, local or manual modes etc. The intent of this section is to ensure that the breaker or switches controls are operating properly.

(5) * Relay Tests – 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 Otter Tail Power operator.

(6) Trip Checks - Protective relaying shall functionally tested to ensure the correct operation of the complete system. Functional testing requires that the complete system is operated by the injection of current and/or voltage to trigger the relay element and proving that the relay element trips the required breaker, lockout relay or provides the correct signal to the next control element. Trip circuits shall be proven through the entire scheme (including breaker trip)

For factory assembled systems, such as inverters the setting of the protective elements may occur at the factory. This section requires that the complete system including the wiring and the device being tripped or activated is proven to be in working condition through the injection of current and/or voltage.

(7) Remote Control, SCADA and Remote Monitoring tests – All remote control functions and

remote monitoring points shall be verified operational. In some cases, it may not be possible to verify all of the analog values prior to energization. Where appropriate, those points may be verified during the energization process

(8) Phase Tests – the Interconnection Customer shall work with Otter Tail Power operator to complete the phase test to ensure proper phase rotation of the Generation and wiring.

(9) Synchronizing test – The following tests shall be done across a open switch or racked out breaker. The switch or breaker shall be in a position that it is incapable of closing between the Generation System and Otter Tail Power for this test. This test shall demonstrate that at the moment of the paralleling-device closure, the frequency, voltage and phase angle are within the required ranges, stated in IEEE 1547 . This test shall also demonstrate that is any of the parameters are outside of the ranges stated; the paralleling-device shall not close. For inverter-based interconnected systems this test may not be required unless the inverter creates fundamental voltages before the paralleling device is closed.

ii) On-Line Commissioning Test – the following tests will proceed once the Generation System has completed Pre-testing and the results have been reviewed and approved by Otter Tail Power operator. For smaller Generation Systems Otter Tail Power may have a set of standard interconnection tests that will be required. On larger and more complex Generation Systems the Interconnection Customer and Otter Tail Power operator will get together to develop the required testing procedure. All on-line commissioning test shall be based on written test procedures agreed to between Otter Tail Power operator and the Interconnection Customer.

Generation System functionally shall be verified for specific interconnections as follows:

(1) Anti-Islanding Test – For Generation Systems that parallel with the utility for longer then 100msec.

(a) The Generation System shall be started and connected in parallel with Otter Tail Power source

(b) Otter Tail Power source shall be removed by opening a switch, breaker etc.

(c) The Generation System shall either separate with the local load or stop generating

(d) The device that was opened to remove Otter Tail Power source shall be closed and the Generation System shall not reparallel with Otter Tail Power for at least 5 minutes.

iii) Final System Sign-off.

(1) To ensure the safety of the public, all interconnected customer owned generation systems which do not utilize a Type-Certified system shall be certified as ready to operate by a Professional Electrical Engineer registered in the State of Minnesota, prior to the installation being considered ready for commercial use.

iv) Periodic Testing and Record Keeping

Interconnection requirements

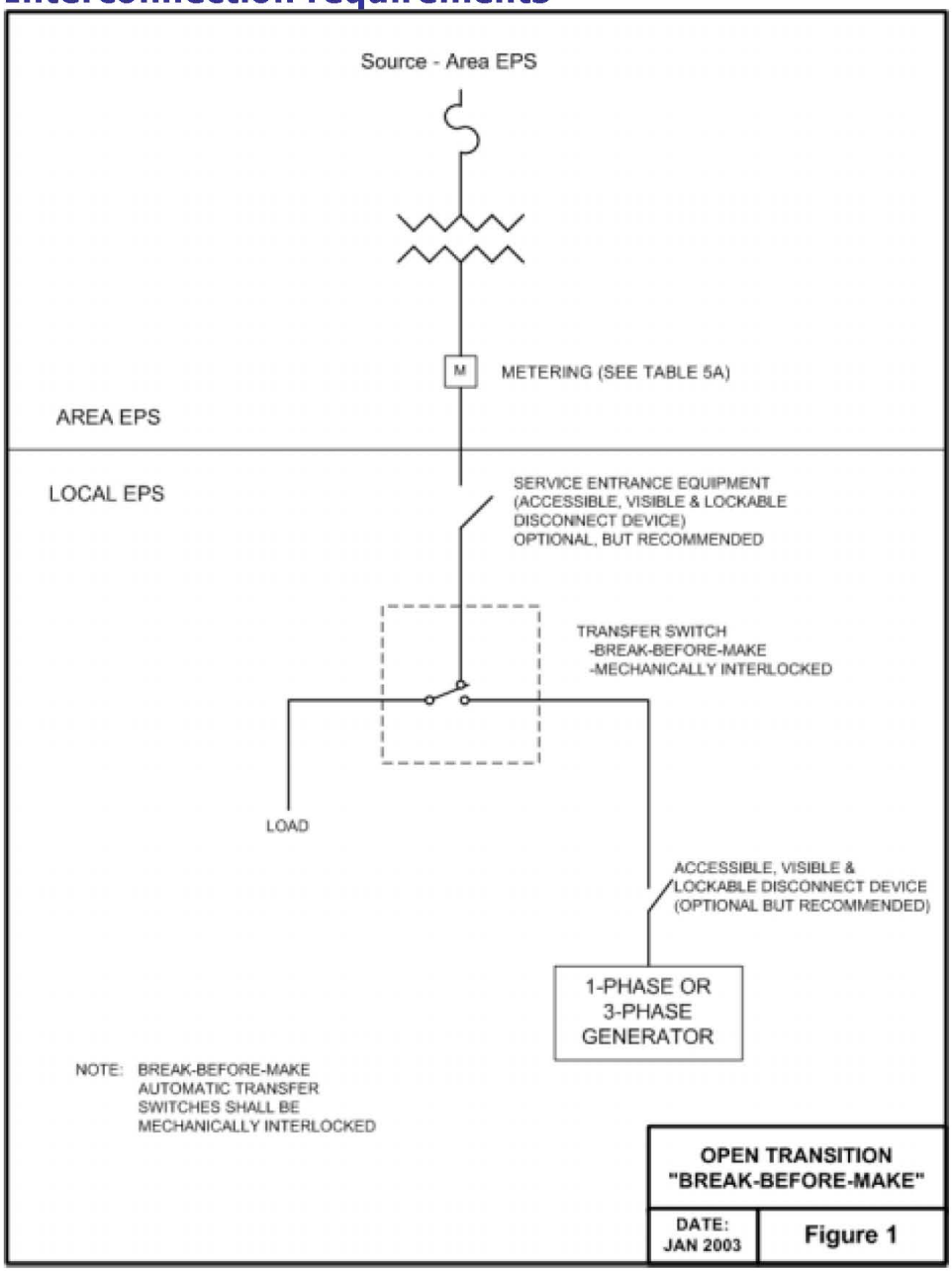
(1) Any time the interface hardware or software, including protective relaying and generation control systems are replaced and/or modified, Otter Tail Power operator shall be notified. This notification shall, if possible, be with sufficient warning so that Otter Tail Power personnel can be involved in the planning for the modification and/or witness the verification testing. Verification testing shall be completed on the replaced and/or modified equipment and systems. The involvement of Otter Tail Power personnel will depend upon the complexity of the Generation System and the component being replaced and/or modified. Since the Interconnection Customer and Otter Tail Power operator are now operating an interconnected system. It is important for each to communicate changes in operation, procedures and/or equipment to ensure the safety and reliability of the Local and Otter Tail Power.

(2) All interconnection-related protection systems shall be periodically tested and maintained, by the Interconnection Customer, at intervals specified by the manufacture or system integrator. These intervals shall not exceed 5 years. Periodic test reports and a log of inspections shall be maintained, by the Interconnection Customer and made available to Otter Tail Power operator upon request. Otter Tail Power operator shall be notified prior to the period testing of the protective systems, so that Otter Tail Power personnel may witness the testing if so desired.

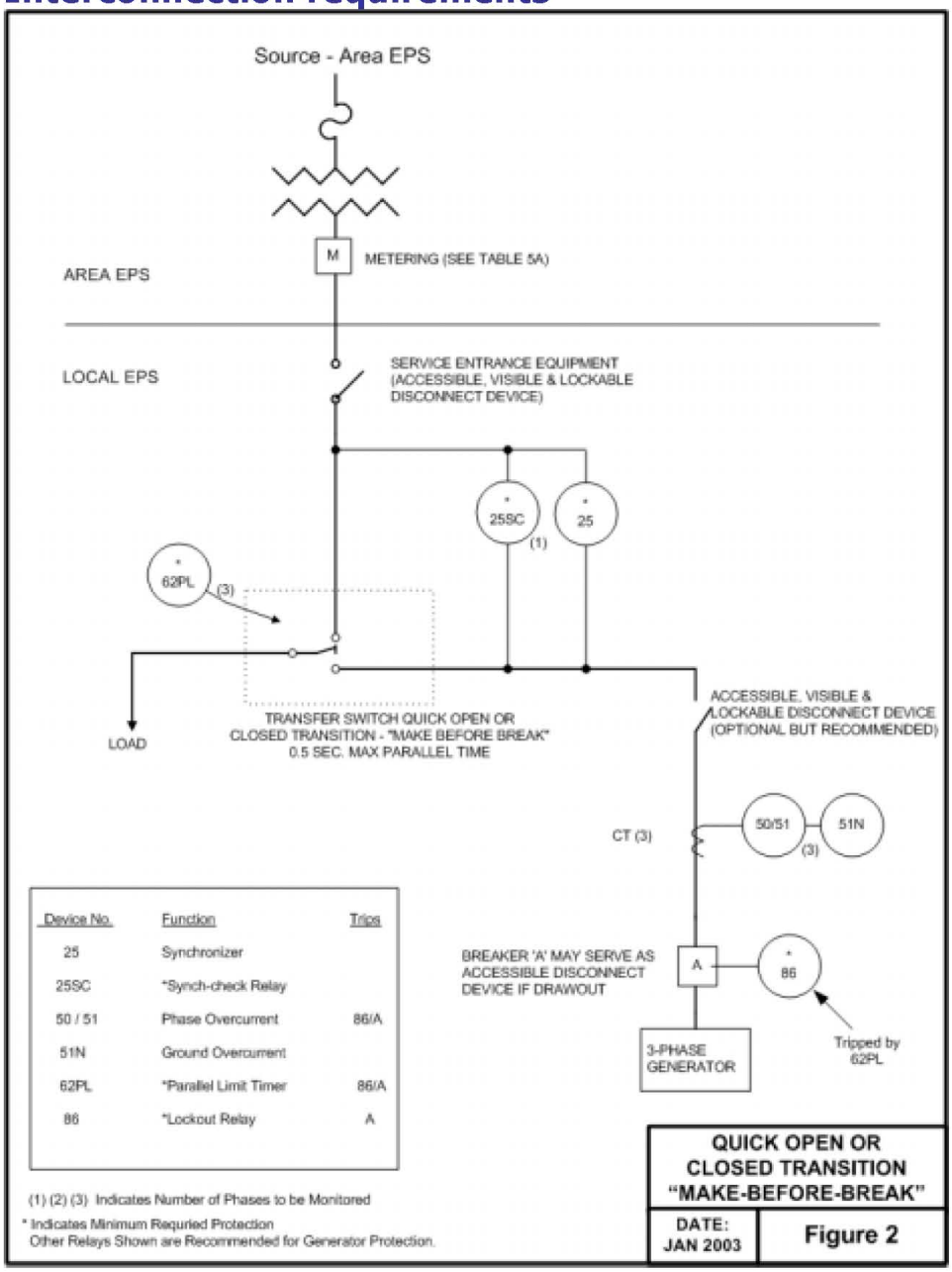
(a) Verification of inverter connected system rated 15kVA and below may be completed as follows; The Interconnection Customer shall operate the load break disconnect switch and verify the Generator automatically shuts down and does not restart for at least 5 minutes after the switch is close

(b) Any system that depends upon a battery for trip/protection power shall be checked and logged once per month for proper voltage. Once every four years the battery(s) must be either replaced or a discharge test performed. Longer intervals are possible through the use of "station class batteries" and Otter Tail Power operator approval.

Interconnection requirements



Interconnection requirements



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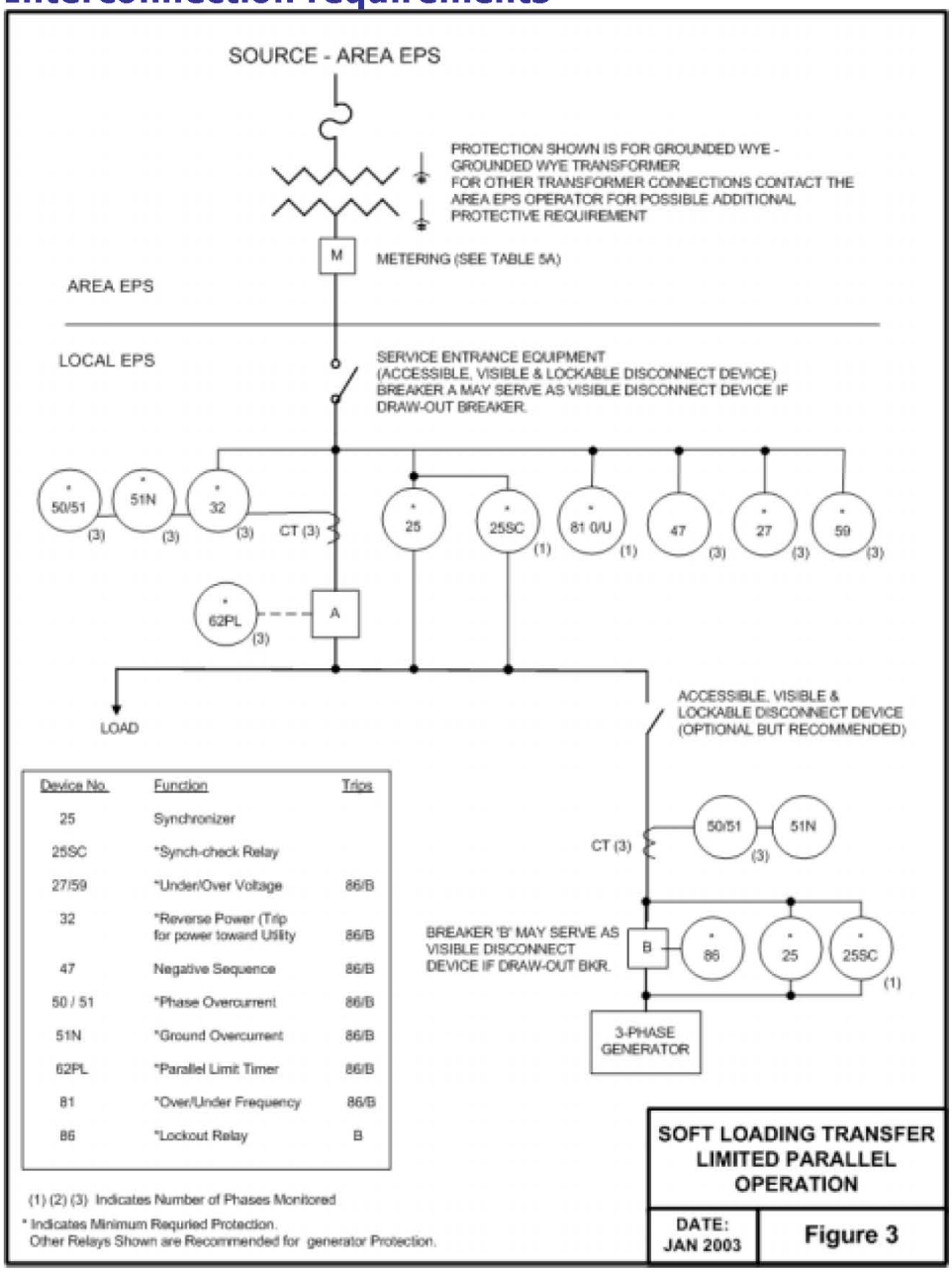
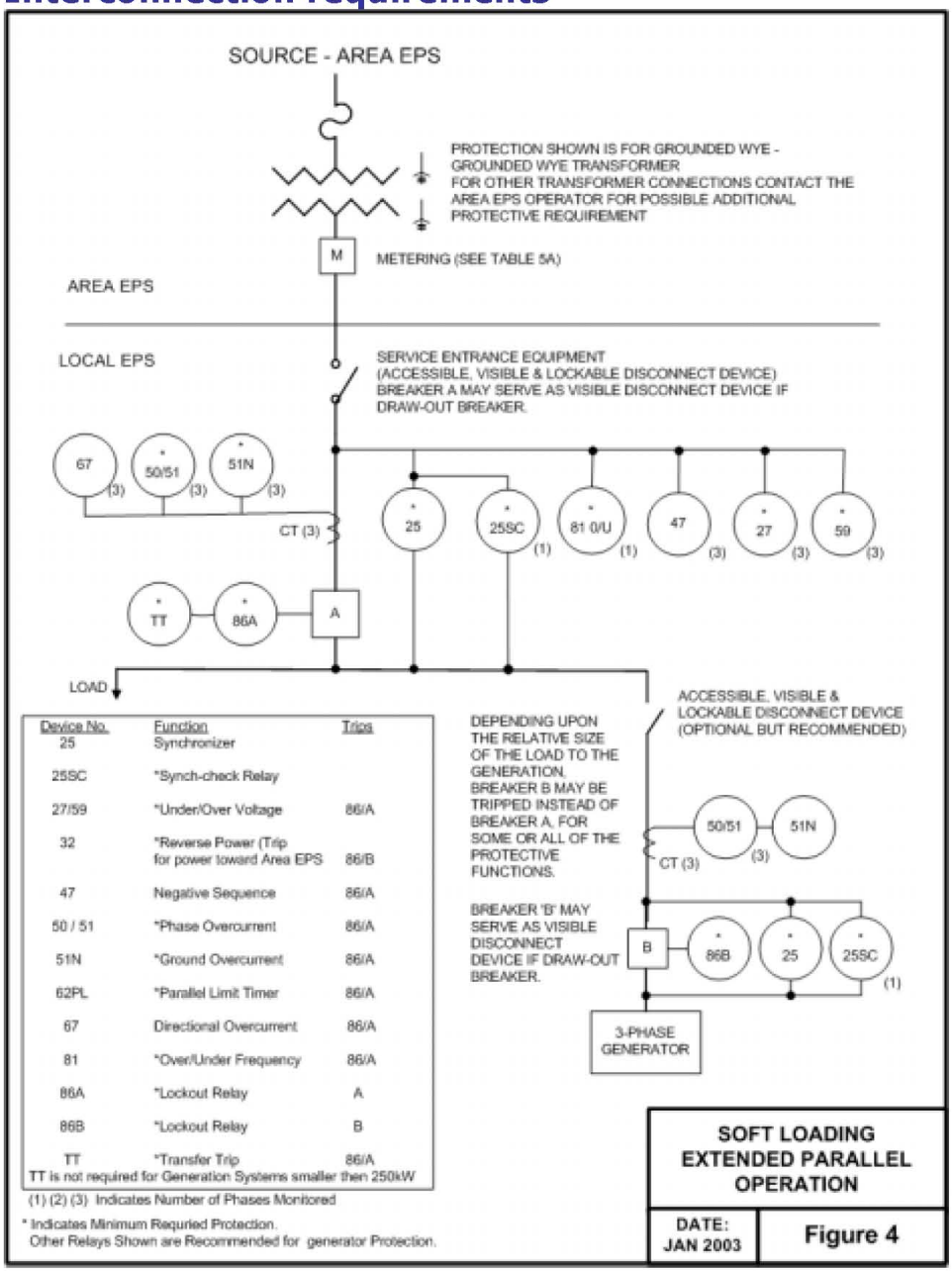


Interconnection requirements



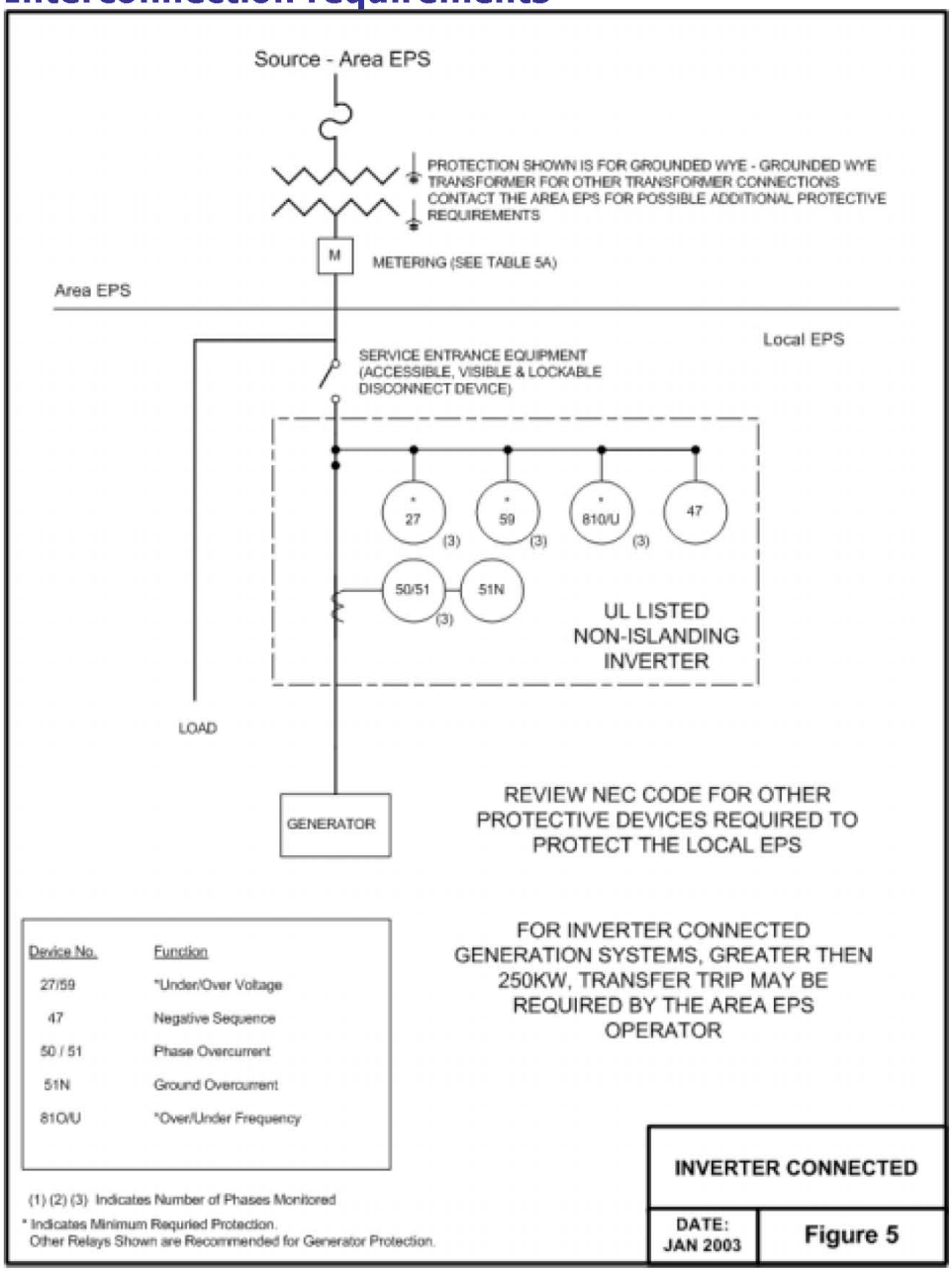
Device No.	Function	Trips
25	Synchronizer	
25SC	*Synch-check Relay	
27/59	*Under/Over Voltage	86/A
32	*Reverse Power (Trip for power toward Area EPS	86/B
47	Negative Sequence	86/A
50 / 51	*Phase Overcurrent	86/A
51N	*Ground Overcurrent	86/A
62PL	*Parallel Limit Timer	86/A
67	Directional Overcurrent	86/A
81	*Over/Under Frequency	86/A
86A	*Lockout Relay	A
86B	*Lockout Relay	B
TT	*Transfer Trip	86/A

TT is not required for Generation Systems smaller then 250kW

(1) (2) (3) Indicates Number of Phases Monitored

* Indicates Minimum Required Protection. Other Relays Shown are Recommended for generator Protection.

Interconnection requirements



Appendix C: SD Distributed Generation Requirements

See South Dakota rules 20:10:36 – Small Generator Facility Interconnection