COGENERATION INTERCONNECTION REQUIREMENTS

Parallel Operation of Connecting Parties' Generation
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I. OBJECTIVE

This document is a supplement to “Division Four Cogeneration and Small Power Production” and “MPW’s Facility Connection Requirements”. It also is designed to comply with the Public Utility Regulatory Policies Act of 1978 (PURPA) and all State and Federal regulatory agencies.

This document states MPW’s minimum requirements for safe and effective operation of a Connecting Parties’ intertie. MPW and Connecting Parties’ engineers shall be guided by this document when planning an intertie between MPW's transmission and distribution system and Connecting Parties’ generation.

MPW will permit any Connecting Party to operate their generating equipment in parallel with MPW's electric system whenever this can be done without adverse effects on MPW Customers, the general public, or to MPW's equipment or personnel. Certain protective devices (relays, circuit breakers, etc.), approved by MPW, shall be installed at any location where a Connecting Party desires to operate generation in parallel with MPW's system. The purpose of these devices is to promptly remove the in-feed from the Connecting Parties’ generation whenever a fault or abnormality occurs, so as to protect MPW Customers, the general public, and MPW's facilities and personnel from damage or injury due to fault currents produced by the Connecting Parties’ generator(s).

Three-phase and single-phase generators may be connected in parallel with the MPW system if the requirements of this document are met and the appropriate approvals as outlined under "Approval Process" are obtained. Employees discovering unapproved parallel operating generator(s) shall report their findings to MPW's Director of Operations, who will initiate the appropriate review and approvals. The Connecting Parties’ generator(s) shall be disconnected from the system until all reviews and approvals are obtained. Exceptions are provided for in Appendix B of this document.

MPW shall not assume any responsibility for protection of the Connecting Parties’ generator(s), or of any portion of the Connecting Parties’ electrical equipment. The Connecting Party is solely responsible for protecting his equipment in such a manner that faults or other disturbances on MPW’s system do not cause damage to the Connecting Parties’ equipment.

The Connecting Party shall be responsible for the costs resulting from the additional equipment, studies, and testing that is required to permit parallel operation. Connecting Party is also responsible to obtain all local, state, federal, and regional approvals needed before parallel operation can begin.
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II. DEFINITION

MPW – Muscatine Power & Water is a municipal electric, water, and telecommunication utility serving 27 square miles in and around Muscatine, Iowa.

MPW Customer – Is the end user of electricity within MPW’s service territory with no generation or transmission facilities.

Connecting Party – This is the party requesting to interconnect or modifying an existing interconnection to MPW’s system. This can include a generator owner, transmission owner requesting interconnect, or MPW Customers (end-user).

Facility Connection Requirements – This document outlines the general requirements to properly interconnect or modify an existing interconnection to MPW’s system to avoid degrading the reliability of the electric system to which it is connected.

Division Four Cogeneration and Small Power Production – This document outlines the general requirements for non-utility generation facilities under the Public Utility Regulatory Policies Act of 1978 (PURPA).

FERC – Federal Energy Regulatory Commission is a commission under the U.S. Department of Energy responsible for ensuring U.S. utilities under their jurisdiction follow all U.S. regulations. MPW is not under FERC jurisdiction.

IUB – Iowa Utility Board is the Iowa State regulating body responsible for regulating the Utilities in Iowa according to the laws of Iowa.

MAPP – Mid-Continent Area Power Pool is the organization responsible for the overall security and operation of the region that MPW belongs to.

NERC – North American Electric Reliability Council is the organization responsible for the overall security and operation of the North American continent.

SCADA – Supervisory Control and Data Acquisition – Computer driven system that provides MPW System Control with the real-time status of MPW’s system including but not limited to breaker control and status, generation, transmission, and distribution facility loading, and automatic generation control (AGC).

“Electric Customer Service Handbook” – This handbook includes in more detail the type and class of service that MPW will provide to MPW customers (end-users) including details on service extensions, metering, billing, customer communications, and customer obligations. This document is provided to our customers when they apply for service.
“Water and Electric Rate Pamphlet” – This pamphlet discusses MPW Customers water and electric rates in detail including the power factor penalty. It is provided to our customers upon request.

“System Restoration Plan” – This plan includes in more detail than provided in this document the procedures, responsibilities, and sequence of events that will occur in the event of a system collapse. This document has limited distribution to ensure system security.

“Watt-hour Meter and Associated Equipment Inspection and Testing Program” – This program discusses the details of how the KWH and KVARH meters and associated equipment will be inspected and tested including the accuracy desired and how often they will be tested.

Inverter – Equipment that converts direct current (dc) to alternating current (ac). Any static power converter with control, protection, and filtering functions used to interface an electric energy source with an electric utility system. (IEEE 929-2000)

Islanding – A condition in which a portion of the utility system that contains both load and distributed resources/generation remains energized while isolated from the remainder of the utility system. (IEEE 929-2000)
III. INTERCONNECTION FACILITIES

A. General Requirements

These general requirements apply to all inverters, three-phase, and single-phase generators that may be operated in parallel with MPW’s system. All generators, 75 KW and greater shall be connected three-phase. Section III. B. provides additional requirements for three-phase generators. Section III. C. provides additional requirements for single-phase generators.

1. As a first step in gaining MPW approval for parallel operation, the Connecting Party shall complete and sign MPW's "Application for Parallel Operation with Utility Service".

Note:

If the Connecting Party desires to isolate a portion of his load on his generation, the connecting party will not utilize any MPW facilities to deliver energy to his load, and will at no time operate in parallel with MPW’s system; approval by MPW is not required.

2. It is the responsibility of the Connecting Party requesting interconnection to ensure that all study requirements and data are submitted to the appropriate bodies to ensure the needed local and regional approval of the project. The studies will include, but not be limited to, powerflow, system stability, and short circuit studies if deemed necessary. Powerflow analysis will include 10-year load or resource growth projections and the planned facilities needed to satisfy such requirements. MPW will be held harmless if approvals are not obtained.

If the new facility causes operational problems on the local or regional system, even if studies have shown problems would not develop, it is the responsibility of the Connecting Party to correct any operational problems that develop after the facility is in service.

The cost of studies and MPW review of the studies shall be borne by the Connecting Party regardless of whether the studies are prepared by the Connecting Party, MPW, or consultant.

3. Any protective relaying or equipment additions or changes on properties of MPW that may be required by interconnection with the Connecting Parties’ equipment shall be accomplished by MPW at the Connecting Parties’ expense. This may include the upgrading of transformer insulation levels and lightning arrester
ratings and the replacement of protective devices (such as circuit breakers and fuse cutouts) due to increased fault current levels.

4. MPW may require, at Connecting Parties’ expense, a dedicated transformer(s) for the equipment.

5. The Connecting Party shall be solely responsible for properly synchronizing their equipment with MPW’s system.

6. Safety - The Connecting Party shall comply with applicable safety laws and building and construction codes, including provisions of applicable Federal, State, or local safety, health, or industrial regulations or codes.

The Connecting Party shall not energize a de-energized MPW circuit. The necessary control devices shall be installed by the Connecting Party to prevent energization of a MPW circuit.

To ensure the safety of Connecting Parties’ and MPW personnel and because of the possibility of energizing a de-energized line, Connecting Party shall furnish and install a manually operated isolating switch with visible break. The purpose of this device is to isolate the Connecting Parties’ equipment from MPW’s system at a location specified by MPW, accessible by only MPW personnel, and capable of being locked in both the open and closed position by MPW personnel only. Depending on Connecting Parties’ operating and maintenance requirements, more than one isolating switch may be required. See Appendix B for all 10 kW and smaller renewable energy installations. Also see Appendix A, Figure 9 installation for example drawings dealing with renewable energy inverter type installations.

MPW reserves the right to open this disconnecting device, isolating the Connecting Parties’ equipment, for any of the following reasons:

a. The Connecting Parties’ equipment causes objectionable interference with other customer’s electric service, or with the operation of MPW’s system.

b. The Connecting Parties’ equipment output exceeds the operating boundaries outlined in Section III. A. 6.

c. The Connecting Parties’ control and protective equipment constitutes a hazardous condition. MPW reserves the right to verify on demand all protective equipment including relays, circuit breakers, etc. at the intertie location. Verification may include the tripping of the tie breaker by the protective relays.
d. Personal safety is threatened.

7. The Connecting Parties' generating equipment shall not cause objectionable interference with the electric service provided to other customers served by MPW. In order to minimize the interference of the Connecting Parties' parallel generation with MPW's electric service operation, the Connecting Parties' generation shall meet the following criteria:

a. **Voltage Regulation** - The Connecting Parties' generating equipment shall not cause excessive voltage excursions. The Connecting Party will operate his generating equipment in such a manner that the maintained voltage levels as dictated by MPW System Control. The typical ranges under normal conditions are provided in Table III-1 below. The Connecting Party shall provide an automatic method of disconnecting his generating equipment from MPW's system if the voltage cannot be maintained within this tolerance.

<table>
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<tr>
<th>TABLE III-1: MPW'S VOLTAGE CRITERION</th>
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<td>CONDITION</td>
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The voltage criterion is set to ensure the equipment shall not burden the system due to its reactive power requirements. The equipment shall provide its reactive power needs at all times.

b. **Voltage Flicker and Sag** - Voltage flicker associated with the sudden addition or removal of generation should be kept to a minimum. It is preferred that Connecting Party flicker be below the Border Line of Visibility curve in Figure 10.3 in IEEE 519 – 1992. Connecting Parties' flicker must be below the Border Line of Irritation curve in Figure 10.3 in IEEE 519 – 1992. It is the responsibility of the Connecting Party that is the source of the voltage flicker to correct any voltage flicker problems that may develop.

Voltage sags due to fault shall be kept to a minimum. Automatic reclosing of a faulted facility shall be limited to one (1) reclosing on the transmission system and three
(3) reclosing on the distribution system. Repeated reclosing on a faulted facility to “burn a fault clear” or “test” to see if the fault is clear is unacceptable and will not be tolerated. The fault should be either cleared or switching completed to isolate the fault before reclosing is attempted.

c. **Frequency** - The operating frequency of the Connecting Parties’ equipment shall be 60 hertz. The Connecting Party shall provide an automatic method of disconnecting his equipment from MPW’s system if the frequency cannot be maintained. Under frequency relaying, if utilized, shall be set as approved by MPW.

d. **Harmonics** - The Connecting Party shall meet or exceed the recommended practices and requirements outlined in IEEE 519 – 1992 Recommended Practices and Requirements for Harmonic Control in Electric Power System. It is the responsibility of the Connecting Party or Parties that are the source of the harmonics to correct any harmonic violation that may develop. The equipment shall not introduce excessive distortion onto MPW's sinusoidal voltage wave. The maximum allowable voltage distortion must not exceed 5% of the fundamental 60 hertz frequency for the square root of the sum of the squares of the harmonics, and 2% of the fundamental for any individual harmonic which shall be measured at the Connecting Parties’ service point.

e. **Fault and Line Clearing** - The Connecting Party shall be responsible for removing his equipment from connection (prevent “Islanding”) with MPW's system instantaneously in the event of an outage on the electric facilities serving his premises. This is to prevent reclosing out of synchronism with the Connecting Parties’ equipment or adverse affects to any other MPW customers within the “island”.

f. **Interconnection Voltage** - Voltage at the point of interconnection shall be specified by MPW and shall be one of MPW's standard voltages.

8. MPW may require that a communications channel be installed, at Connecting Parties’ expense, as part of the relay protection scheme. This channel may be a leased telephone circuit, microwave, fiber optic cable or other means, to be determined by MPW.
9. If MPW is requested to do work on the Connecting Parties’ premises, an inspection of the work area may be made by MPW operating personnel. If hazardous working conditions are detected, the Connecting Party shall be required to correct the unsafe condition before MPW will perform the requested work.

10. Parallel service offered under the conditions outlined herein is subject to the electric service contract terms and provisions under which electrical energy is sold to the Connecting Party. Demands established on the billing meter and demand carryovers and minimums shall be billed as prescribed in the rate schedule for the applicable class of service.

11. In general, a Connecting Party that desires to sell power shall modify his wiring to accommodate a second watt-hour meter in series with the existing watt-hour meter. MPW shall install two watt-hour meters with detents. One meter shall measure and record the energy sold to the Connecting Party and the other meter shall measure and record energy purchased from the Connecting Party. If the Connecting Party elects to have parallel generation with MPW but does not desire to sell energy to MPW, MPW shall replace the existing watt-hour meter with a watt-hour meter with detent. The cost of the second watt-hour meter or the extra cost of a watt-hour meter with detent shall be at the Connecting Parties’ expense. See number 12 for exceptions to this rule.

12. The exception to number 11 above deals with the installation of renewable energy systems that are 10 kW and smaller and use an inverter. In this case only one meter with no detent will be installed to allow for net metering of the system. See Appendix B of this document for further clarification.
B. Three-Phase Generators - Special Requirements

The following requirements refer to three-phase generator installations. These requirements are in addition to those outlined in Section III. A.

1. The protective devices (relays, circuit breakers, etc.) required to promptly remove the fault contribution from the Connecting Parties’ generation, shall be owned, operated, and maintained by MPW. In those cases where MPW ownership is not practical, as determined by MPW, the protective equipment may be owned by the Connecting Party. In these instances, however, the following stipulation shall apply:

a. All protective devices, installed to protect MPW’s system from Connecting Parties’ infeed, shall be approved by MPW.

b. The installation and check-out of these devices shall be supervised by MPW and subject to MPW approval.

c. All relay settings on the intertie shall be approved by MPW.

d. MPW reserves the right to verify, on demand, the calibration and operation of all protective equipment including relays, circuit breakers, etc. at the intertie location. Verification may include the tripping of the tie breaker by the protective relays.

The Connecting Party has sole responsibility for the routine maintenance of his generating and protective equipment. Complete maintenance records shall be maintained by the Connecting Party and be available for MPW review.

Failure of the Connecting Party to provide proper routine maintenance shall result in the Connecting Party being required to cease parallel operation.

e. Switching of the main tie circuit breaker shall be under the operating direction of MPW. MPW reserves the right to open the disconnecting device to the Connecting Party for any of the following reasons:

1. System emergency.
2. Inspection of Connecting Parties’ generating equipment and/or protective equipment reveals a hazardous condition, a lack of scheduled maintenance, or lack of maintenance records.

3. The Connecting Parties’ generating equipment interferes with other customers or with the operation of MPW’s system.

2. The Connecting Party shall be warned that certain conditions on MPW's system may cause negative sequence current to flow in the Connecting Parties’ generator. It is the sole responsibility of the Connecting Party to protect his equipment from excessive negative sequence currents.

3. No fuses or single-phase automatic line switching devices, such as oil circuit reclosers, may be installed between the MPW source substation and the MPW Connecting Parties’ substation. Single-phase sectionalizing equipment may be installed on the main circuit past the Connecting Parties’ substation, or on radial circuits that tap the main circuit between the source substation and the Connecting parties’ substation. (See Figures 3, 4A, 4B, 4C, & 6 for examples of source and Connecting Parties' substations.)

4. On radial transmission and distribution circuits, a potential transformer and voltage-check scheme shall be installed on MPW’s substation breaker. Three phase oil circuit reclosers located between the source substation and the Connecting Parties’ substation shall be equipped with this voltage-check scheme in addition to the substation circuit breaker. This scheme shall be designed to inhibit manual and automatic reclosing to a hot line, so that the intertie cannot be accidentally re-established (after a line fault or bus differential, for example) with the Connecting Parties’ generator(s) out of phase with MPW's system. Thus, if Connecting Parties’ generation remains connected to an isolated, unfaulted line, it shall be necessary for the Connecting Party to manually trip his machine, so that the substation breaker can be reclosed, and the circuit re-connected to the supply bus. If Connecting Party can be connected to more than one MPW circuit, the voltage-check scheme must be installed on the alternate circuit(s) as well as the primary feed. The addition of this voltage check scheme shall be at Connecting Parties’ expense.

5. MPW shall not connect Connecting Parties’ generator(s) in parallel with its system through power transformers protected by high-side fuses. This policy is intended to reduce the possibility
of damage to the Connecting Parties’ machine(s) due to negative-sequence currents and avoid the possibility of fusing being used to tie Connecting Parties’ generator to MPW’s system.

6. Except in rare instances, to be determined by MPW, all Connecting Parties’ generators shall be isolated from MPW owned equipment by a power transformer. This transformer shall be connected in such a manner as to isolate the zero-sequence network of the Connecting Parties’ generator from the zero-sequence network of MPW’s system. MPW shall decide whether this power transformer shall be delta connected, wye-connected solidly grounded, grounded through an impedance, or ungrounded at the interconnection line voltage.

7. Direct current generators may be operated in parallel with MPW’s system through a three-phase synchronous inverter. The inverter installation shall be designed such that a MPW system interruption shall result in the instantaneous removal of the inverter infeed to MPW’s system. Harmonics generated by an inverter interface shall not cause any reduction in the quality of service provided to other MPW customers. Connecting Party shall conduct, under MPW supervision, a harmonic study to determine the impact of adding the inverter to MPW’s system. Modifications to MPW’s system required because of additional harmonics shall be at Connecting Parties’ expense.

C. Single-Phase Generators - Special Requirements

The following requirements refer to single-phase generator installations. These requirements are in addition to those outlined in Section III. A.

These requirements are directed toward single-phase generators tapped on radial distribution circuits 34KV and below. Single-phase generators are strictly prohibited from interconnecting to MPW’s transmission and sub transmission network.

1. It shall be the Connecting Parties’ responsibility to provide adequate protection and control scheme and to utilize quality equipment so as to meet:

   a. The requirements of this policy.
   
   b. Applicable electrical and safety codes.
   
   c. The criteria of all applicable licensing authorities.
2. The Connecting Party shall be required to install, operate, and maintain in good order and repair, and without cost to MPW, all facilities required for the safe operation of the generation facilities in parallel with MPW's system.

3. MPW normally applies automatic reclosing to overhead distribution circuits. When MPW's source breaker trips, the Connecting Party shall insure that his generator is disconnected from MPW's circuit prior to automatic reclosure by MPW. Automatic reclosing out-of-phase with the Connecting Parties' generator may cause damage to Connecting Parties equipment. The Connecting Party is solely responsible for the protection of his equipment from automatic reclosing by MPW.

D. Inverters - Special Requirements

The following requirements refer to inverter installations. These requirements are in addition to those outlined in Section III. A. For a typical one line diagram and protection scheme see Appendix A Figure 9.

1. It shall be the Connecting Parties' responsibility to provide adequate protection and control scheme and to utilize quality equipment so as to meet:

   a. The requirements of this document.

   b. Applicable electrical and safety codes. See section VII

   c. The criteria of all applicable licensing authorities.

2. The Connecting Party shall be required to install, operate, and maintain in good order and repair, and without cost to MPW, all facilities required for the safe operation of the generation facilities in parallel with MPW's system.

3. MPW normally applies automatic reclosing to overhead distribution circuits. When MPW's source breaker trips, the Connecting Party shall insure that his inverter is disconnected from MPW's circuit prior to automatic reclosure by MPW. Automatic reclosing out-of-phase with the Connecting Parties' inverter may cause damage to Connecting Parties equipment. The Connecting Party is solely responsible for the protection of his equipment from automatic reclosing by MPW.

4. In order for MPW to promptly remove or clear faulted conditions the connecting party shall install protection equipment and prevent islanding conditions as required in IEEE 929-2000. This
protective equipment will be owned, maintained, and tested annually by the connecting party.

5. Any accessing of an inverters program to change Anti-Islanding or protection properties is prohibited, unless approved by MPW.

6. For systems that are smaller than 10 kW see Appendix B, titled “Interconnection Agreement for Renewable Energy Net Metering 10 kW and Smaller”.
IV. OPERATING RELIABILITY REQUIREMENTS

A. Operations Planning

1. Maintenance Coordination

   a. Generating Plant Maintenance - MPW develops generating plant maintenance schedules, typically one year in advance. Maintenance is most often scheduled during the spring and fall when peak demand for electrical energy is lowest. As the time approaches for a particular generator to be removed from service for maintenance, MPW evaluates its remaining capacity, taking into account scheduled interchange and scheduled and forced generator outages, and adjusts the maintenance schedule if insufficient capacity seems likely. The Connecting Parties’ generator will be included in this assessment; therefore the Connecting Party and MPW must coordinate their scheduled maintenance.

   b. Transmission Maintenance - Transmission line maintenance usually requires that one or more lines be removed from service. It is important for the Connecting Party to know which lines MPW has planned for maintenance, especially those which connect the Connecting Parties’ generator to MPW’s system. Similarly, MPW needs to know for its contingency analyses if the Connecting Party is planning to remove its transmission line(s) from service. (Contingency analysis simulates the operation of a power system with a given generation and transmission configuration.)

2. Staffing

   a. MPW maintains a highly trained staff to operate its generating and transmission system facilities. Similarly, the Connecting Parties’ generating facility should employ, or obtain the service of, a staff properly trained in the operation of their electric facilities. MPW and Connecting Parties’ system operators must coordinate the operation of their respective systems. Each should keep the other informed of the status of labor or other agreements
and circumstances which could affect the availability of its operating personnel.

3. **Training**
   
a. MPW’s system configuration, operating conditions, equipment, and operating techniques are constantly changing. Therefore, operator training must be an ongoing process for both MPW and the Connecting Parties’ generating facility personnel. This training should include familiarization with normal and emergency interconnected operating procedures of MPW, the pool, the region, and NERC. The Connecting Party should consider participating in training sessions with MPW’s personnel from time to time.

4. **System Studies**
   
a. MPW regularly studies its system by modeling it with computers. These computer models allow MPW to study how the system will react to various equipment malfunctions and other expected and unexpected disturbances. Studies include determining operating limits due to thermal, stability, and voltage requirements. Data from the Connecting Parties’ facility is needed as part of the system model. MPW will provide appropriate study results to the Connecting Party, especially when the studies show operating problems of which the Connecting Party needs to be aware.

5. **Operating Procedures**
   
a. **Normal Procedures** - Coordination of Connecting Parties’ generating facility policies and procedures with those of MPW is needed for reliable day-to-day operations. MPW and the Connecting Party should keep each other up to date on current operating guidelines.

   b. **Emergency Conditions** - Dealing with emergency conditions requires that MPW and Connecting Party have a precise understanding of each others’ contingency plans and procedures. Specifically, any procedures that require Connecting Party generator participation to avert stability limit violations, thermal
overloads, abnormal system frequency or voltage, load curtailment or system separation must be carefully understood and coordinated.

c. Switching and Clearance Procedures - MPW has established switching and clearance procedures to insure the safety of the public and MPW's personnel. These procedures must be followed precisely. The Connecting Parties’ procedures must be consistent with those of MPW.

B. System Operations - Normal Conditions

During normal operating conditions, the Connecting Party will have control of its generation and should observe the following considerations:

1. Communications

   MPW maintains reliable communications facilities for the continuous monitoring of its system conditions. Similarly, MPW will need information about the Connecting Parties' generation facilities conditions, such as load, generation, voltage, reactive schedule, transmission line and switching orders, safety-related and emergency procedures, fuel supply, personnel status, and other conditions that could affect operating reliability.

   a. Communications Equipment - Communications between the Connecting Party and MPW must be both adequate and reliable. There must be sufficient, dependable channels to handle voice and telemetering communications.

   b. Daily Operating Reports - Energy accounting includes all purchases and sales, transaction cost and price, and the production at each generating plant. The Connecting Parties’ generating facilities must likewise keep reports on hourly generation unit output and total energy produced, and furnish this information daily to MPW. Also, for generating units above a minimum size, as determined by MPW, the Connecting Party shall continuously telemeter generator output, voltage, and delivered energy information to MPW.
2. **Generation Control**

a. **Control Area** - The Connecting Parties' generator must either function as an isolated control area or operate as part of MPW's control area. If isolated, the control area must adjust its generation to meet its constantly changing demand. If interconnected with MPW, it must adjust its generation to meet interchange voltage and frequency schedules as specified by MPW.

b. **Generation Schedule** - The Connecting Parties' generation schedule is needed by MPW so that MPW can accurately match generation, demand, and scheduled interchange. This schedule should be agreed upon by all involved. The Connecting Parties' generation facility should abide by this schedule, unless equipment or other operating problems interfere.

c. **Governor** - The governor regulates the output of the generator as a function of system frequency. That function (called the governor's "droop" characteristic) must be coordinated with the governors of MPW's generating units to assure good system response to frequency variation. Ideally, the Connecting Party generator's governor should be allowed to respond to system frequency to help maintain the interconnected system's stability.

3. **Transmission Loading**

MPW's and the Connecting Parties' generators' transmission lines must be operated within their thermal, voltage, and stability limits. These limits are determined, at least in part, from the system studies mentioned above in Section IV. A.

4. **Operating Reserves**

MPW maintains operating reserves to provide for the unexpected outage of generating and transmission equipment. This reserve may be "spinning," that is, capacity remaining on generators not producing at their maximum output, or "nonspinning," such as off-line, quick-start gas turbine generators, load management, or interruptible load. MPW must also consider the sudden, unexpected loss
(malfunction) of Connecting Parties’ generation or transmission when calculating its (MPW’s) operating reserves requirement.

5. Voltage and Reactive Supply

Both MPW and Connecting Parties’ generator must maintain an adequate reactive supply and proper voltage control. This is necessary so that the Connecting Parties’ generator can reliably deliver its generation without jeopardizing the transmission system. The Connecting Parties’ generating facility may consider installing a power system stabilizer if stability studies indicate a need. A power system stabilizer dampens oscillations in the generator’s exciter caused by system disturbances or perturbations. If these oscillations are left unchecked, the generator can become unstable and trip off line.

6. Protection Systems

Protective relays detect abnormal system conditions and trip circuit breakers on generations and transmission equipment to prevent their damage or injury to utility personnel or the public. The Connecting Parties’ generating facility should likewise equip its facilities with protective relays. Overspeed and under frequency relays should be considered. Because the Connecting Parties' generator and MPW simultaneously perceive the same operating conditions; their relay settings (the level at which they are set to trip) must be coordinated. The Connecting Parties’ generator should change its relay settings only after coordinating with MPW. Furthermore, the Connecting Parties' generator and MPW have the responsibility of testing and maintaining their relay systems to insure they will work when needed and as designed.

7. Interchange Scheduling

When the Connecting Parties’ generator's energy is transferred from one location to another, regardless of distance, through MPW's transmission and distribution system, a transmission service agreement with MPW will be necessary to provide a transmission path from the Connecting Parties’ generator to the receiving location.

8. Unit Commitment
Unit commitment is the selection of generators that will be placed on line to serve expected demand and provide adequate operating reserve. Unit commitment schedules are often adjusted daily to meet changing system conditions. The Connecting Parties’ generator’s unit commitment schedule must be coordinated with MPW to assure that there will be sufficient generating capacity on line to meet these requirements.

9. **Switching**

The safety of Connecting Party and MPW personnel is critical. Switching errors can seriously - even fatally - injure personnel or damage equipment. The Connecting Parties’ generating facility must coordinate its switching operations with MPW in accordance with mutually agreeable procedures. (See also Switching and Clearance Procedures.)

10. **Deliveries Across Control Area Boundaries**

There may be instances where a Connecting Parties’ generator will deliver its energy into MPW's control area for purchase by a utility in another control area. This energy must be scheduled using the normal scheduling practices of the two control areas. The Connecting Party should initiate the necessary contractual arrangements for the delivery. (See Interchange Scheduling.)

C. **System Operations - Emergency Conditions**

An emergency condition exists when the reliability of MPW’s or interconnected system is in jeopardy and/or customer service is threatened. Depending on the season and other circumstances, an interruption in service may only be an inconvenience to a few of the utility's customers, or it may be life-threatening and involve hundreds or thousands of people. MPW and the other interconnected utilities have developed precise operating procedures to deal with system emergencies with the goal being safe and rapid service restoration.

If there is a generation deficiency, MPW will first call on its own operating reserves, then begin purchasing emergency power from its neighboring systems. If the generation deficit still exists after purchasing all available power, MPW may implement a voltage reduction, shed its interruptible customers, or issue public appeals...
to decrease use. Only after these measures fail to mitigate the emergency will MPW turn to shedding firm load.

During emergency conditions, the Connecting Party may be asked to place the control of its generator under the direction of MPW until the utility has determined that its (MPW's) system and the interconnected systems have returned to normal operation.

1. **Generation Control**

   MPW must determine when generation should be adjusted, brought on line, or shut down. The Connecting Parties’ generator should be able to alter its generation schedule as directed by MPW's system operators.

2. **Restoration Procedures**

   Restoration requires an orderly plan for safely and rapidly reestablishing transmission service, which is a prerequisite for restoring customer electric service. Generation must be carefully regulated as customers are reconnected to the system to maintain the supply/demand balance. Lines or substations may need to be switched out of service temporarily.

   a. **Generation** - If the Connecting Parties' generator has been isolated from MPW's system, it will be allowed to reconnect under the direction of MPW's system operators. The Connecting Parties' generator should be ready to serve load as soon as possible.

   b. **Transmission** - To assure personnel safety and provide rapid restoration, the Connecting Parties’ generator’s transmission lines should be reconnected to MPW’s system only under the direction of MPW's system operators.

   c. **Customers** - MPW will approve restoring customer load associated with Connecting Parties' generation as soon as adequate generation and transmission in the interconnected system becomes available.

3. **Load/Generation Reduction**

   If MPW cannot supply its customers' demand, it may need to reduce load by load shedding, usually as a last resort.
The Connecting Parties’ generator may be expected to reduce its (industrial) load as well, and adjust its generation, as required, under the direction of MPW’s system operators.

4. **Schedule Changes**

Just as utilities notify each other when they need to adjust their interchange schedules during normal conditions, during an emergency, the Connecting Party should consult MPW before changing its generation schedule. This is to assure that MPW can maintain its generation/demand balance, and keep inadvertent interchange to a minimum. If this is not possible, the Connecting Party should notify MPW as soon as practicable after changing its schedule.

5. **Communications**

MPW, the Connecting Party, and all other involved utilities must maintain contact with each other during an emergency. Timely restoration requires that everyone be continuously aware of system conditions.

6. **Voltage Adjustment**

The Connecting Party should keep its automatic voltage regulator in operation during an emergency unless MPW asks that manual adjustments be made. This will keep the voltage on the system within proper limits, and aid in system restoration. If MPW implements a voltage reduction, the Connecting Parties’ generator must participate, as directed by MPW’s system operators.

7. **Transmission Priorities**

Utilities often engage in many interchange transactions with other systems at the same time. Therefore, they establish interchange (or transmission) priorities so that should an emergency arise, there is a plan for rearranging the interchange schedules. These priorities consider the thermal and stability limits of the transmission system, temporary operating limits, and overall operating conditions. The Connecting Party should follow the directives of MPW regarding transmission loading and limitations. Also, if transmission limitations alter the Connecting Party...
generator's operations, the Connecting Party should notify MPW as soon as practical.

D. Transmission Planning

1. Reliability Studies

MPW, and perhaps other utilities, may perform reliability studies to determine how the Connecting Parties’ generator will impact the transmission systems. These studies, if conducted, typically include transmission capacity limits, the impact of parallel path flows, the effect of generator shutdowns, and available techniques to improve the reliability of the transmission system. (See System Studies.)

2. Transmission Capacity

Transmission planning studies, which utilities regularly conduct, determine when transmission system additions or changes are needed. These plans must include the details of the Connecting Parties’ generator and its associated transmission facilities to assure that the Connecting Parties’ generator can be reliably integrated into the interconnected system.

3. Parallel Flow

During interchanges between utilities, seldom does the entire contracted power flow over the contracted (service agreement) transmission path. Because the interconnected system consists of a network of transmission lines, the electricity will flow over various parallel paths from utility to utility. Often, these paths are through utilities that are not parties to the contracted exchange and there is the possibility that the transaction could overload a part of these systems. Therefore, when a Connecting Parties’ generator’s energy is being delivered to a purchasing entity beyond MPW’s system, the parallel path flow, as well as the contract path flow, must be considered to assure that the transaction will not jeopardize the interconnected system’s reliability.

Similarly, when a Connecting Parties’ generator's energy is to be delivered to a load center within MPW's system, power will flow over the various parallel paths provided by MPW's transmission, sub transmission, and distribution.
network. Therefore, it will be necessary to evaluate these types of interchange in a manner similar to the above.

4. **Transmission Priorities**

Transmission system overloading may be mitigated with schedule adjustments based upon priorities established by MPW, the Connecting Parties’ generator, and utilities involved in the transmission service agreement.
V. **CLASSIFICATION OF INSTALLATIONS WITH GENERATION**

The following general classifications indicate the major operating characteristics and minimum protection requirements for typical installations.

These classifications are determined in part by the electrical size of the generator. The term generator refers to the sum of all electrical generating capacity at the same site. A large generator is defined as any generator 5 MVA or larger. All other generators are considered small.

An increased degree of protection is required for large generation installations because of increased short circuit contributions from larger units and an increased investment by MPW in substation equipment. The larger transformers and circuit breakers needed to serve the Connecting Parties’ load requires more sensitive and faster protection schemes.

Table V-1 below indicates the important characteristics of the eight types of installations. This table will direct the reader to the appropriate installation type. Each classification is reviewed individually in the following sections, which give a general overview of the types of parallel connections approved for service on MPW’s system.

<table>
<thead>
<tr>
<th>Type</th>
<th>Generator Size less than 5 MVA</th>
<th>Number of Phases</th>
<th>System Connection</th>
<th>Two-Way Power Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No</td>
<td>3</td>
<td>Network Line</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>3</td>
<td>Network Bus</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>No</td>
<td>3</td>
<td>Radial Line</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>3</td>
<td>Radial Line</td>
<td>Yes</td>
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<td>5</td>
<td>No</td>
<td>3</td>
<td>Network Line</td>
<td>No</td>
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</tr>
<tr>
<td>8</td>
<td>Yes</td>
<td>1</td>
<td>Radial Line</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table notes:

1. Protective schemes as shown on Figures 1 through 8B in Appendix A may be modified to meet specific installation requirements.

2. Single-phase generators are covered under Type 8. Single-phase generators, 10 KVA or less, will be allowed at practically any point on MPW’s distribution system if they meet the requirements of this document. Single-phase generators between 10 KVA and 75 KVA may be allowed depending on the point of connection to MPW’s system.
3. Inverter based renewable energy systems 10 kW and smaller is covered under Appendix B of this document. Connecting Party must meet the requirements of Appendix B only for this type of system. See Appendix A, Type 9 for sample drawing of inverter based system.

A. Type 1 Installation - Large Generator on Network Line

1. A Type 1 installation is connected to MPW's transmission system on lines rated 69KV and above.

2. This type of installation provides for the flow of power in either direction as a normal operating mode.

3. Figure 1, Appendix A shows the major equipment and protective relaying required for Type 1 installations.

   a. MPW ownership and maintenance of Power Circuit Breaker (PCB) A is required to protect MPW equipment and personnel. The proper functioning of MPW's system and the safety of substation and line maintenance personnel is dependent upon the correct operation of PCB A and the protective relay scheme.

4. The Connecting Party shall bear that portion of the costs resulting from the additional equipment that shall be installed to allow for parallel operation. The Connecting Parties' contribution shall be determined by MPW and included with the service contract.

5. The revenue metering for Type 1 installations shall include two watt-hour meters with detents. One meter shall be connected to measure and record energy supplied to the Connecting Party from MPW. The other meter shall be connected to measure and record the energy supplied to MPW by the Connecting Party. The meter detents will prevent operation of either meter in the reverse direction.

B. Type 2 Installations - Large Generator on a Network Bus

1. A Type 2 installation is connected to a 69KV or above network bus on MPW's transmission system.

2. This type of installation provides for the flow of power in either direction as a normal operating mode.

3. Figure 2, Appendix A shows the major equipment and protective relaying required for Type 2 Installations.
a. MPW ownership and maintenance of Power Circuit Breaker (PCB) A is required to protect MPW equipment and personnel. The proper functioning of MPW’s system and the safety of substation and line maintenance personnel is dependent upon the correct operation of PCB A and the protective relay scheme.

4. The Connecting Party shall bear that portion of the costs resulting from the additional equipment that shall be installed to allow for parallel operation. The Connecting Parties' contribution shall be determined by MPW and included with the service contract.

5. The revenue metering for Type 2 installations shall include two watt-hour meters with detents. One meter shall be connected to measure and record energy supplied to the Connecting Party from MPW. The other meter shall be connected to measure and record the energy supplied to MPW by the Connecting Party. The meter detents will prevent operation of either meter in the reverse direction.

C. Type 3 Installations - Large Generator on Radial Line

1. Type 3 installation is tapped on a radial line. This line has a single utility substation source.

2. This type of installation provides for the flow of power in either direction as a normal operating mode.

3. Figure 3, Appendix A shows the major equipment and protective relaying required for Type 3 Installations.

a. MPW ownership and maintenance of Power Circuit Breaker (PCB) A is required to protect MPW equipment and personnel. The proper functioning of MPW’s system and the safety of substation and line maintenance personnel is dependent upon the correct operation of PCB A and the protective relay scheme.

4. The Connecting Party shall bear that portion of the costs resulting from the additional equipment that shall be installed to allow for parallel operation. The Connecting Parties' contribution shall be determined by MPW and included with the service contract.

5. The revenue metering for Type 3 installations shall include two watt-hour meters with detents. One meter shall be connected to measure and record energy supplied to the Connecting Party from MPW. The other meter shall be connected to measure and record the energy supplied to
MPW by the Connecting Party. The meter detents will prevent operation of either meter in the reverse direction.

D. Type 4 Installations - Small Generator on Radial Line

1. Type 4 installation is connected to a radial line.

2. This type of installation provides for the flow of power in either direction as a normal operating mode.

3. Figure 4A, 4B, and 4C, Appendix A indicate three acceptable connections for this type of installation. Figure 4A shows the delta-delta transformer with a high-side circuit breaker. Figure 4B shows a fused delta-delta transformer with a low-side circuit breaker. Figure 4C shows a grounded wye-delta transformer with a high side oil circuit recloser.

4. The preferred scheme for Type 4 installations is shown in Figure 4A. The high-side circuit breaker (A) is a three-phase interrupting device which inhibits single phasing of the generator. The high-side potential phasors and voltage relay connections are shown on the figure.

5. Device 47 in Figure 4B is applied to prevent damage to the Connecting Parties’ generator due to blown fuses on the high-side of the transformer, and the Connecting Party shall be made aware that his generator is exposed to negative sequence currents with this type of connection.

6. The schemes described in Figure 4A and 4B may also be employed if the power transformer is connected grounded-wye on the low-voltage side. In this case, a current transformer shall be installed in the neutral to supply current to a back-up ground relay.

7. Figure 4C shows a pole-mounted grounded wye-delta transformer installation that may be used when a ground type substation is not practical. The high side protection for this type of substation is a three-phase electronic recloser (A) with phase and ground overcurrent sensing. Note that the (3) potential transformers and their relays are connected to the low (delta) side.

8. The Connecting Party shall bear that portion of the costs resulting from the additional equipment that shall be installed to allow for parallel operation. The Connecting Parties’ contribution shall be determined by MPW and included with the service contract.

9. The revenue metering for Type 4 installations shall include two watt-hour meters with detents. One meter shall be connected to measure and record energy supplied to the Connecting Party from MPW. The other...
meter shall be connected to measure and record the energy supplied to MPW by the Connecting Party. The meter detents will prevent operation of either meter in the reverse direction.

E. Type 5 Installations - Large Generator on Network Line

1. A Type 5 installation may be used in any case where the Connecting Parties’s load greatly exceeds his generating capacity.

2. This type of installation does not allow the flow of power from the Connecting Party to MPW.

3. Figure 5, Appendix A shows the major equipment and protective relaying required for Type 5 installations. Note that Power Circuit Breaker (PCB) A shall be tripped by a reverse power relay (32) if the Connecting Parties’ generation exceeds the Connecting Parties’ load. If PCB A is open, the Connecting Parties’ bus shall be de-energized before PCB A can be closed. The Connecting Parties’ generation can then be synchronized and paralleled with MPW’s system by closing PCB B.

4. The Connecting Party shall bear that portion of the costs resulting from the additional equipment that shall be installed to allow for parallel operation. The Connecting Parties’ contribution shall be determined by MPW and included with the service contract.

5. This type installation requires a single watt-hour meter with detent.

F. Type 6 Installations - Small Generator on Radial Line

1. A Type 6 installation may be used in any case where the Connecting Parties’ load greatly exceeds his generating capacity.

2. This type of installation does not allow the flow of power from the Connecting Party to MPW.

3. Figure 6, Appendix A shows the major equipment and protective relaying required for Type 6 installations. Type 6 installations shall only be allowed in those small substations where a high or low-side breaker is not practical. Note that MPW must have trip control over Connecting Parties’ Power Circuit Breaker (PCB) A. Refer to Section III. B. Item 1. for detailed description of installation, operating, and testing requirements. The negative sequence relay, device 47, shall trip the generator PCB A and the load PCB B. A device 47 operation indicates a single-phase condition requiring the tripping of both the generation and load.
Reverse power relay (32) shall trip PCB A if the Connecting Parties’ generation exceeds the Connecting Parties’ load.

The Connecting Parties’ control scheme for PCB A shall be designed to allow for the closing of PCB A if the feed from MPW is energized and the Connecting Parties’ generator is in synchronism with MPW’s system. The Connecting Party shall obtain approval from MPW operating personnel prior to closing PCB A if the MPW source is de-energized. This provision is required to protect line and substation maintenance personnel.

4. The Connecting Party shall bear that portion of the costs resulting from the additional equipment that shall be installed to allow for parallel operation. The Connecting Parties’ contribution shall be determined by MPW and included with the service contract.

5. This type of installation requires a single watt-hour meter with detent.

G. Type 7 Installations - Small Generator on Network Line

1. A Type 7 installation is connected to MPW’s transmission system (69KV or above).

2. This type of installation provides for the flow of power in either direction as a normal operating mode.

3. Figure 7, Appendix A shows the major equipment and protective relaying required for Type 7 installations. Devices 159, 81, 59/27 form the basic additional protection for the intertie.

4. The Connecting Party shall bear that portion of the costs resulting from the additional equipment that shall be installed to allow for parallel operation. The Connecting Party contribution shall be determined by MPW and included with the service contract.

5. The revenue metering for Type 7 installations shall include two watt-hour meters with detents. One meter shall be connected to measure and record energy supplied to the Connecting Party from MPW. The other meter shall be connected to measure and record the energy supplied to MPW by the Connecting Party. The meter detents will prevent operation of either meter in the reverse direction.
H. Type 8 Installations - Small Single-Phase Generator on Radial Distribution Line

1. A Type 8 installation is connected to a MPW radial distribution line rated 13.8 kV.

2. This type of installation provides for the flow of power in either direction as a normal operating mode.

3. Figure 8A and 8B, Appendix A show two different types of single phase Connecting Parties’ generation connections that may be approved for parallel operation. These examples do not include all possible configurations.

4. The Connecting Party shall bear that portion of the costs resulting from the additional equipment that shall be installed to allow for parallel operation. The Connecting Parties’ contribution shall be determined by MPW and included with the service contract.

5. The revenue metering for Type 8 installations shall include two watt-hour meters with detents. One meter shall be connected to measure and record energy supplied to the Connecting Party from MPW. The other meter shall be connected to measure and record the energy supplied to MPW by the Connecting Party. The meter detents will prevent operation of either meter in the reverse direction.
VI. **APPROVAL PROCESS**

To assure uniformity in the application of the procedures of this document, the approvals for any parallel operation shall be made by MPW’s Engineering Department.

For the purposes of this document, those installations requiring substation additions or modifications, whether interconnecting at transmission or distribution voltage levels, shall be considered Transmission Projects. Installations tapping distribution lines and requiring no substation additions or modifications shall be considered Distribution Projects.

A. The Engineering Department shall forward each application for parallel operation with MPW to the Director of Operations, who will forward copies to the General Manager, and Director of Finance. If the applicant is interested in the sale of electrical energy to MPW, the negotiations will be jointly held with the General Manager, Director of Operations, and Director of Finance.

B. If the applicant has interest in the project after the feasibility study stage, the Director of Operations, shall forward the application as described below.

**Transmission Projects**

Parallel operation installations requiring substation additions or modifications shall be coordinated within MPW by the Director of Operations. Installation Types 1, 2, 3, 4A, 4B, 5, 6, and 7 will normally be Transmission projects. MPW’s Engineering Staff shall determine the interconnection requirements, the required protective apparatus, and furnish an estimate of the cost to provide such service. This evaluation may require a meeting with the Connecting Party to determine technical service requirements before the appropriate protective/control scheme can be estimated. The Director of Operations will direct MPW’s Engineering Staff to evaluate the proposed operation on MPW's electrical system and to ensure that these systems are compatible for parallel operation. In addition, he will keep the General Manager informed of the project and the progress thereof.

**Distribution Projects**

Parallel operation installations tapping distribution lines and requiring no substation additions or modifications shall be coordinated within MPW by the Director of Operations. Installation Types 4C, 8A, and 8B will normally be Distribution projects. MPW’s Engineering Staff shall determine the interconnection requirements, the required protective apparatus, and furnish as
estimate of the cost to provide such service. This evaluation may require a meeting with the Connecting Party to determine technical service requirements before the appropriate protective/control scheme can be estimated. The Director of Operations will direct MPW’s Engineering Staff to evaluate the proposed operation on MPW’s electrical system and to ensure that these systems are compatible for parallel operation. In addition, he will keep the General Manager informed of the project and the progress thereof.

C. If an energy purchase arrangement by MPW is indicated, this information will then be reviewed by the General Manager, Director of Operations, and Director of Finance. The Director of Operations will advise the applicant of the engineering and operating criteria and the cost of the interconnection to be borne by the applicant so that this cost can be considered in the economic evaluation of the project. The method of payment for the interconnection costs shall be in accordance with rules set forth by the Utilities Division of the Iowa Department of Commerce.

D. If the applicant decides to continue with the project, MPW will negotiate and administer a contract for service. The final approving authority for this contract will be The Board of Water, Electric, and Communications Trustees.

E. MPW’s approvals described herein shall not be construed as a warranty of safety, durability, or reliability of the Connecting Parties’ interconnection, generation, service facilities, control devices, or protective devices. The Connecting Party shall be solely responsible for protecting its equipment in such a manner that faults or disturbances do not cause damage to the Connecting Party, MPW, or MPW Customer's equipment.

F. It is the responsibility of the Connecting Party requesting interconnection to ensure that all study requirements and data are submitted to the appropriate bodies to ensure the needed local and regional approval of the project. The studies will include, but not be limited to, powerflow, system stability, and short circuit studies if deemed necessary. Powerflow analysis will include 10-year load or resource growth projections and the planned facilities needed to satisfy such requirements. MPW will be held harmless if approvals are not obtained. The cost of studies and MPW review of the studies shall be borne by the Connecting Party regardless of whether the studies are prepared by the Connecting Party, MPW, or consultant. If the new facility causes operational problems on the local or regional system, even if studies have shown problems would not develop, it is the responsibility of the Connecting Party to correct any operational problems that develop after the facility is in service.
G. It is the Connecting Parties' responsibility to ensure that all generator testing required by local and regional bodies are submitted. This can include but is not limited to annual MAPP URGE (Uniform Rating of Generating Equipment) tests and MAPP/NERC dynamic tests.

H. Approval for inverter based renewable energy systems 10 kW and smaller is covered in Appendix B.
VII. REFERENCE

The Connecting Party shall meet the standards as determined by MPW. Current American National Standards Institute (ANSI), Institute of Electrical and Electronics Engineer (IEEE), Iowa Administrative Code (IAC), National Electric Code (NEC), and National Electric Safety Code (NESC) publications shall be used for guidelines in determining these standards. Applicable publications include but are not limited to the following:

A. IEEE Guide for Protective Relaying of Utility-Consumer Interconnection, ANSI/IEEE C37.95

B. General Requirements for Synchronous Machines, ANSI C50.10. Rule 8.1 “Maximum allowable deviation factor,” is modified to read: “The deviation factor of the open-circuit terminal voltage wave and the current wave at all loads shall not exceed 0.1. Deviation factor shall be as defined in ANSI C42.100.

C. Requirements for Salient Pole Synchronous Generators and Condensers, ANSI C50.12.

D. Requirements for Cylindrical-Rotor Synchronous Generators, ANSI C50.13.


F. Iowa Electrical Safety Code, as defined in IAC (199) Chapter 25.

G. National Electric Code, ANSI/NFPA No. 70.


J. Inverters, Converters, and Controllers for Use in Independent Power Systems, UL1741 & UL 1703
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APPENDIX A: PROTECTION SCHEMES

The figures included in this Appendix provide a general guide only for generator or inverters and their system protection. They will need to be modified to meet the specific installation requirements. Causes for these modifications can include: Connecting Parties’ operating and maintenance requirements, fault current contributions, available fault current, system location, Connecting Parties’ risk tolerance, and Syncing requirements
FIGURE 1: Type 1 – Large Three-Phase Generator on Network Line
FIGURE 2: Type 2 – Three-Phase Generator on Network Bus.
FIGURE 3: Type 3 - Large Three-Phase Generator on Radial Line
FIGURE 4A: Type 4A – Small Three-Phase Generator on Radial Line
FIGURE 4B: Type 4B – Small Three-Phase Generator on Radial Line
FIGURE 4C: Type 4C – Small Three-Phase Generator on Radial Line
FIGURE 5: Type 5 – Large Three-Phase Generator on Network Line
FIGURE 6: Type 6 – Small Three-Phase Generator on Radial Line
FIGURE 7: Type 7 – Small Three-Phase Generator on Network Line
FIGURE 8A: Type 8A – Small Single-Phase Generator on Radial Distribution Line
FIGURE 8B: Type 8B – Small Single–Phase Generator on Radial Distribution Line
FIGURE 9: Inverter – Installation of inverter located on a Secondary Line
APPENDIX B

Interconnection Agreement for Renewable Energy Net Metering 10 kW and Lower
Interconnection Agreement for
Renewable Energy Net Metering
Between
Muscatine Power and Water
And

__________________
(Customer)

This Interconnection Agreement (Agreement) for Renewable Energy Net Metering is
entered into on __________, 20___ (Effective Date) by and between __________
(Customer), ________________(address), and Muscatine Power and Water (MP&W), a
Municipal Utility in the State of Iowa.

RECITALS

A. Renewable Energy Net Metering Service is available to MP&W Customers that
are supplied electric service by MP&W under all rate schedules and that own, operate and
maintain an eligible Renewable Energy System in parallel with MP&W electric system.

B. The Customer owns an eligible Renewable Energy System and will install and
maintain it in compliance with all applicable National Electric Code requirements, building
codes, and MP&W Electric Service Rules.

C. The Customer desires to connect the eligible Renewable Energy System to
MP&W electric system.

D. MP&W has mechanisms in place through its Electric Tariff and Electric Service
Rules to accommodate the Customer’s request.

NOW, THEREFORE, in consideration of the mutual promises and covenants contained
within this Agreement, the parties agree as follows:

AGREEMENT

1. SYSTEM DEFINED

The Customer’s eligible Renewable Energy System is a self-contained electric generation
system comprising: direct current disconnect apparatus, inverters for the conversion of
direct current to alternating current, alternating current disconnect/lockout, over-current
protective device, and all other related electrical equipment upstream of the over-current
protective device (all such equipment described as the “System” within this Agreement).
The System begins and continues up-stream from the over-current protective device on the Customer’s premises. (an additional recording meter is not required for all MP&W rate schedules).

2. TERM AND TERMINATION

2.1 The term of this Agreement begins on the Effective Date (regardless of the date that the Customer is authorized to interconnect the System pursuant to Section 5 below) and continues for five (5) consecutive 12-month periods, and then will renew for additional 12-month periods continuing until either party chooses to terminate the agreement.

2.2 The Customer may terminate this Agreement at any time by providing 30 days written notice of termination to MP&W.

2.3 MP&W may terminate this Agreement at any time for any violation of this Agreement by providing 15 days written notice to the Customer. As provided in Section 3 below, this Agreement is at all times subject to the terms of, changes to, and revisions to, MP&W rate structure and Electric Service Rules and other related regulatory authorizations.

2.4 This agreement shall automatically terminate on the 10th day following the sale or transfer of the Customer’s premises. In the event of such sale or transfer the Customer shall notify the new buyer of this Interconnection Agreement and the new buyer shall promptly sign the MP&W forms to reaffirm this Agreement. Failure of the buyer to reaffirm this Interconnection Agreement within ten days of the sale or transfer will allow MP&W to perform lock out procedures as provided herein. The right to reaffirm this Interconnection Agreement may not be withheld by MP&W unless the system fails to meet the requirements established in Section 4 of this agreement.

2.5 At the time of termination of this Agreement for any reason, MP&W will perform lock out procedures to disconnect the Customer’s System from MP&W electric system.

3. TARIFF AND REGULATORY AUTHORITIES

3.1 Renewable Energy Net Metering Service is available to MP&W Customers that are supplied electric service by MP&W under all rate schedules and that own, operate and maintain an eligible Renewable Energy System in parallel with MP&W electric system.

3.2 This Agreement is subject to: all present and future applicable laws, rules, regulations, certificates, decisions, orders and directives of the Board and all federal, state and local authorities having jurisdiction over the subject matter of this Agreement; and This Agreement will be deemed to include all such changes referred to in the initial sentence of this subsection, or any other changes that
become effective by operation of law or Board, or City Council resolution, without prejudice to the Customer’s right to protest those changes.

4. INSTALLATION AND PERMITTING

4.1 The Customer and the System must comply with: 1) all applicable National Electric Code (NEC) requirements, including, but not limited to NEC Articles 690 and 705; 2) all building codes; and 3) all applicable Underwriters Laboratories (UL) requirements and standards. At its sole expense, the Customer must: 1) obtain all necessary electrical permit(s) for the installation of the System, and 2) obtain and maintain any governmental authorizations or permits that may be required for the operation of the System. The Customer must reimburse MP&W for any and all losses, damages, claims, penalties, or liability MP&W incurs as a result of the Customer’s failure to obtain or to maintain any governmental authorizations and permits that may be required for construction and operation of the Customer’s System.

4.2 The Customer or its contractor must fill out Exhibit A and B and construct the System as specified in the attached Exhibit A.

4.3 A manual, lockable, load-break disconnect switch that provides a clear indication of the switch position must be available with the System at or near the Customer’s main point of service from MP&W electric system to provide a point of electrical separation between the Customer’s System and MP&W electric system. MP&W will coordinate and approve the location of the disconnect switch. The disconnect switch must be easily visible, mounted separately from the metering equipment, readily accessible to MP&W personnel at all times, and capable of being locked in the open position with a MP&W lock. MP&W may open the disconnect switch thereby isolating the Customer’s System from the MP&W electric system for any reason that MP&W deems necessary (including, but not limited to, maintenance or emergency work, the System adversely affecting other customers of MP&W, failure of the System to comply with codes/regulations, the System creating hazardous or unsafe conditions, the Customer’s failure to pay utility bills when due, failure to comply with UL Standard 1741 (Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Systems), or failure to comply with UL Standard 1703 (Standard for Safety: Flat-Plate Photovoltaic Modules and Panels).

4.4 All rate schedules within MP&W system do not require the second metering point for this level of renewable generation.

4.5 The System must comply with all Institute of Electrical and Electronics Engineers (IEEE) Standards 929-2000 (Recommended Practice for Utility Interface of Photovoltaic Systems), as of the Effective Date, for parallel operation with MP&W. The purpose of these IEEE Standards is to minimize custom engineering of many aspects of the interconnection. These standards allow installation in a manner that will allow the System to perform as expected and to be installed at a reasonable cost while not compromising safety or operational issues.
All power quality parameters (that is, voltage, flicker, frequency, distortion) are specified at the point of common coupling (PCC) unless otherwise stated. In particular, the following requirements must be met:

4.5.2 Flicker – Any voltage flicker resulting from the connection of the inverter to MP&W’s electric system at the PCC cannot exceed the limits defined by the maximum borderline of irritation curve identified in IEEE Std. 519-1992.

4.5.3 Frequency – the System must have a fixed frequency range of 59.3-60.5 Hz.

4.5.4 Waveform Distortion – the System must have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to MP&W electric system. The System electrical output at the PCC must comply with Clause 10 of IEEE Std. 519-1992. The key requirement is that total harmonic distortion must be less than 5% of the fundamental frequency current at rated inverter output. Each individual harmonic is limited to the percentages listed in IEEE Std. 519-1992.

4.5.5 Power Factor – The System must operate at a power factor > 0.90 (leading or lagging) when output is greater than 10%.

4.5.6 Islanding Protection – The System must cease to energize the utility line when the inverter is subjected to islanding conditions. The Customer’s System must immediately, completely and automatically disconnect from MP&W electric system in the event of a fault on the Customer’s System, a fault on MP&W electric system or loss of source on MP&W electric system. MP&W, at its own discretion and expense, may conduct periodic testing of anti-islanding.

4.6 The Customer’s over-current protective device (Breaker) at the service panel must be dedicated and must be capable of interrupting the maximum available fault current. The Breaker shall be clearly marked to indicate power source and connection to MP&W electric system. MP&W will provide and attach an additional label to the manual load-break disconnect switch, which is described in Subsection 4.3 above.

4.7 The Customer, at its own expense, must pay for any additional equipment required to connect the System to MP&W electric system.

5. WRITTEN AUTHORIZATION REQUIRED TO CONNECT SYSTEM

5.1 The Customer may not connect the System to the MP&W electric system until: 1) this Agreement has been executed by the parties, 2) the System has been tested, and 3) written authorization to connect the System, in a form substantially similar to the attached Exhibit C, has been given to the Customer by MP&W. MP&W may have representatives present at the initial testing of the Customer’s System and may perform (at its own expense) whatever testing of the Customer’s System that MP&W deems necessary. If MP&W does not complete the witness test within 10 business days from receipt of the Certificate of Completion the
witness test is deemed waived. (See FERC Order No. 2006-B, Attachment 5, number 6). This waiver of a witness test enables the customer to operate its system in parallel with MP&W’s system.

5.2 After written authorization to connect the System to MP&W electric system has been given, the Customer shall make no changes or modifications in the System or of its mode of operation without the prior written approval of MP&W.

5.3 The extent of the initial testing will be determined at an earlier meeting between customer and MP&W and will stay in effect as long as the customer does not modify the system in any way as representative of Exhibit A.

6. LOCATION OF SYSTEM

The System will be installed at the Customer’s premises located at in the physical location specified or depicted in the attached Exhibit A The Customer cannot relocate the System to another premises or physical location without the prior written approval of MP&W. In the event that such approval is given, any relocation and installation of the System will be at the Customer’s sole expense.

7. NET METERING

The term “Net Metering” as used within this Agreement refers to the use of a single meter connected system (no second meter required). The Net process is accomplished on the customer’s original point of metering.

8. RENEWABLE ENERGY CREDITS

The Customer expressly understands and agrees that all Environmental Attributes, including but not limited to, air quality credits, “Green tags,” and renewable energy credits, that are created by the installation, existence and operation of the System shall belong to MP&W. MP&W may report or register ownership of the Environmental Attributes with any entity and may utilize those Environmental Attributes (or transfer them) in any manner.

9. ACCESS TO PREMISES

The Customer will allow access to its premises and to the System by MP&W personnel in accordance with the MP&W Service Rules: (i) to inspect the Customer’s System, (ii) to read and to replace meters; (iii) to open the load-break disconnect switch, and (iv) to disconnect the interconnection facilities at MP&W meter or transformer.
10. MAINTENANCE OF EQUIPMENT

At its sole expense, the Customer will maintain the System, including but not limited to, all over-current protective equipment, in a safe and prudent manner and in conformance with all applicable laws, codes and regulations, including, but not limited to, the requirements of Section 4 above. The Customer must maintain all records for such maintenance. These records must be available to MP&W for inspection at all reasonable times.

11. DISPUTE RESOLUTION

Should a dispute arise between the parties with regard to the Service provided under this Agreement, any such dispute may be reviewed and determined in accordance with the Dispute Resolution Procedure as provided in MP&W Tariff and Electric Service Rules, Utilities Rules and Regulations.

12. SAFETY

The Customer agrees to install, to operate and to maintain the System in a safe and prudent manner and in conformance with all applicable laws, codes and regulations including, but not limited to, those contained within Section 4 above.

13. SEVERABILITY

If any provision of this Agreement is found to be illegal or unenforceable, then the remaining provisions of this Agreement will remain in full force and effect, and such term or provision will be deemed stricken for as long as it remains illegal or unenforceable.

14. SURVIVAL

The provisions of this Agreement with respect to indemnification and liability will survive the termination of this Agreement.
15. NOTICES AND OTHER COMMUNICATIONS

Except as otherwise expressly provided in this Agreement or as may be specified by the parties in writing, any notice or other communication required under this Agreement must be in writing and must be sent by registered or certified United States mail, or by messenger, or by facsimile, or by other electronic means. Any such notice or other communication must be addressed as follows and, if so addressed, will be effective upon actual receipt.

If to Customer:

Name:
Title:
Address:
Phone:
Fax:
Email:

If to MP&W:

Name:
Title:
Address:
Phone:
Fax:
Email:

16. ENTIRE AGREEMENT

This Agreement, together with its attachments, constitutes the entire agreement between the parties and supersedes all previous written or oral communications, understandings, and agreements between the parties unless specifically stated otherwise within this Agreement. This Agreement may only be amended by a written agreement signed by both parties. Email and all other electronic (including voice) communications from MP&W in connection with this Agreement are for informational purposes only. No such communication is intended by MP&W to constitute either an electronic record or an electronic signature or to constitute any agreement by MP&W to conduct a transaction by electronic means. Any such intention or agreement is expressly disclaimed.
17. ACKNOWLEDGEMENTS REGARDING AGREEMENT

By signing below, the Customer acknowledges that it understands the terms of this Agreement and that the Customer may not connect the System to MP&W electric system until the Customer has received written authorization to connect from MP&W. Within 10 business days after notice from the Customer that the System is ready for interconnection to the MP&W electric system, MP&W will inspect the System and will provide a written authorization to connect the System or a statement that the System may not be interconnected because of non-compliance with this Agreement. (See FERC Order No. 2006-B, Attachment 5, number 6).

THE DULY AUTHORIZED REPRESENTATIVES of the parties have signed three originals of this Agreement.

CUSTOMER

Signature: ________________________________
Printed Name: ______________________________
Address: ________________________________
Utilities Account #: ________________________
Date: ________________________________

MUSCATINE POWER & WATER

Authorized Signature: ________________________________
Printed Name: ________________________________
Title: ________________________________
Date: ________________________________
Exhibit A

To the Interconnection Agreement for Renewable Energy Net Metering between Muscatine Power & Water and ________________, dated ________________.

   Insert description of System and attach drawing
   Fill out application for parallel operations Exhibit B
(Not valid without Make, Model and Voltage of system being installed)
(This page left blank intentionally)
Exhibit B
Application for Parallel Operation
With Utility Services

Customer (Connecting Party):
Name: ___________________  Contact Person: ________________
Address: _________________  Phone: _______________________
_________________________________________________________
Account Number:____________

Consulting Engineer or Contractor:
Name: ___________________ Contact Person: ________________
Address: __________________ Phone: _______________________
_________________________________________________________

Equipment Information:

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General Information:
Type: ( ) Synchronous ( ) Induction ( ) Inverter ( ) Other__________
Energy Source (Wind, Solar, Hydro) _________________
Single Phase( ) Three Phase( )
Rating: ______________ kW
Rated Output: _______A   Rated Voltage: ________Volts
Rated Frequency: _____ Hertz  Rated Current: _______Amps
Efficiency:__________ %   Power Factor: __________
THD: ________________ %   Max Fault Current: _______Amps

External disconnect is mandatory
Location_________________________________________

Meets all applicable Standards and Codes (IEEE, UL, NEC, etc.) Yes( ) No( )
Estimated In-service date: ______________

Customer Signature: __________________________ Title: _____ Date: __________

Contractor Signature:__________________________ Title: _____ Date: __________
(This page left blank intentionally)
Exhibit C

To the Interconnection Agreement for Renewable Energy Net Metering between Muscatine Power & Water and __________________________, dated ________________.

Section A: Authorization. The System may be connected to the Muscatine Power & Water electric system.

The System has been inspected and tested and the Customer is authorized to connect the System to the Muscatine Power & Water electric system.

Signed by:

Printed Name:

Printed Title:

Date:

– OR –

Section B: Non-Authorization. The System cannot be connected to the Muscatine Power & Water electric system.

The System does not comply with the Interconnection Agreement for Renewable Energy Net Metering between Muscatine Power & Water and __________________________, dated ________________. Accordingly, the Customer cannot connect the System to the Muscatine Power & Water electric system.

Signed by:

Printed Name:

Printed Title:

Date: