Willmar Municipal Utilities

"Willmar Municipal Utilities will provide safe, reliable & quality utility services at competitive rates for their customers."

REQUIREMENTS FOR GENERATION, TRANSMISSION, AND END-USER FACILITY INTERCONNECTIONS

Version 3.0

RP3 RELIABLE PUBLIC POWER PROVIDER

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I. INTRODUCTION

A. AUTHORITY

State and federal regulatory agencies having jurisdiction over Willmar Municipal Utilities' (WMU) System, require 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. WMU complies to the existing manuals, standards, and guidelines of the NERC, Midwest ISO, 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 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, Midwest ISO, 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. These requirements are based on today's NERC enforceable standards.

B. OBJECTIVES

The purpose of this document is to provide a template for developing the technical guidelines to interconnect with the WMU Company electric 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 develop the necessary requirements to comply with the North American Electric Reliability Corporation's (NERC) Standard FAC-001.

This template is 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 WMU personnel.
- Maintain the reliability and service of all users of the WMU Bulk Electric System.
- Minimize the possible damage to the property of the general public, WMU Customers, and WMU.
- Minimize adverse operating conditions on the WMU Bulk Electric System.
- Permit the interconnection customer to operate in parallel with the WMU Bulk Electric System in a safe, reliable and efficient manner.
- Accurately measure and account for all injections and extractions from the interconnected system.

C. INTERCONNECTION PROCEDURES

The interconnection procedures for establishing interconnection to the WMU Transmission System are pursuant to Attachment X under the Midwest ISO Open Access Transmission. Additional information may be found on the Company's website at http://www.wmu.willmar.mn.us

II. GENERAL POLICY AND REQUIREMENTS

A. COMPLIANCE WITH INTERCONNECTION REQUIREMENTS

It is the responsibility of the interconnection customer to obtain all permits and approvals of the governing bodies and to comply with all applicable electrical and safety codes. Generator interconnections that fall

under the state jurisdictions are covered under this document and must comply with utility and state specific processes and criteria.

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

B. RESPONSIBILITY AND APPROVAL

Approval of the proposed interconnection only ensures that WMU has reviewed the interconnection to make certain that the WMU Bulk Electric System can be maintained and that other WMU customers are not adversely affected by operation of the interconnecting Facilities.

C. INTERCONNECTION CUSTOMER FINANCIAL OBLIGATION

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

- 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 WMU Bulk Electric 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 WMU's SCADA
- Land, rights-of-way, licensing, permitting, engineering, etc.
- Control Area Services costs

D. NERC COMPLIANCE

If operation of the interconnection customer's Facility causes WMU to be out of compliance with any applicable rules, regulations, and/or requirements of NERC, Midwest ISO, Applicable Reliability Council, or any successor agency assuming or charged with similar responsibilities related to the operation and reliability of the Bulk Electric System, and if WMU is assessed a penalty, fee, or charge for such non-compliance, said penalty will be passed through to the interconnection customer.

E. GREAT RIVER ENERGY AS A BALANCING AUTHORITY AREA OPERATOR

Great River Energy is the Local Balancing Area Operator for Willmar Municipal Utilities' Bulk Electric System. Interconnected Customer will be a part of the GRE Local Balancing Authority Area unless alternative arrangements are made and approved by WMU and GRE for connecting to a different Balancing Authority.

GRE Local Balancing Authority is a member Midwest ISO and participates in the Midwest Energy and Ancillary Services market. GRE Local Balancing Authority has entered into a Balancing Authority and a NERC Joint Registration Organization with the Midwest ISO Balancing Authority. 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 GRE's Local Balancing Authority Area may need to become

marketing participant within the Midwest Energy and Ancillary Services Market.

F. REQUESTS FOR TRANSMISSION SERVICE

The ability to interconnect to the WMU Bulk Electric System does not mean the interconnection customer can deliver or receive power over WMU'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 interconnection customer intends to wheel power over WMU's transmission facilities, the interconnection customer must contact the Midwest ISO concerning obtaining transmission service.

III. GENERAL INFORMATION

A. INTERCONNECTION TYPES

Identified within this section are general requirements that apply to interconnecting generating, end-user and transmission equipment with the WMU Bulk Electric System including three-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.
- Interconnection voltage.
- Interconnection power flow (one-way or two-way).
- Interconnect size, type, or location.
- The scheduling of energy within WMUs Local Balancing Area.
- State interconnection requirements

B. GENERATOR INTERCONNECTIONS

1. CLASSIFICATIONS

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

a. 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 WMU's or other utilities" electric facilities. At a minimum, these installations must demonstrate to WMU's satisfaction their compliance with the WMU design standards.

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

2. GENERATOR TESTING AND PERFORMANCE REQUIREMENTS

The interconnection customer must agree to perform any and all testing of each generator as required by the Applicable Reliability Council and/or the Midwest ISO. The specific testing requirements depend on the type of prime mover for the Facility.

3. 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. The interconnection customer 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, impedance and the power factor capability of the generator. The actual test data must be provided.

4. GENERATOR STEP-UP (GSU) and AUXILIARY TRANSFORMERS

For compliance to VAR-002, interconnection customer must PROVIDE TO WMU, tap settings, available fixed tap ranges, impedance data, the +/- voltage range with step-change in % for load-tap changing transformers for each interconnecting GSU and Auxiliary Transformer.

The available voltage taps of the interconnection customer's step-up transformer will be reviewed by WMU for its suitability with the WMU Bulk Electric System. The interconnection customer is expected to request this review before acquiring the transformer. WMU shall determine which voltage taps would be suitable for a step-up transformer for the Interconnection customer's proposed project. Suitable taps are required to give the transformer the essential capacity for the generator to:

- Deliver maximum reactive power to WMU's System at the Point of Interconnection (generator operating to at least 95 percent lagging power factor).
- Absorb maximum reactive power from WMU's System (generator operating to at least 95 percent leading power factor).
- Help maintain a specified voltage profile on WMU's system for varying operating conditions.

5. AUTOMATIC GENERATOR CONTROL – 50 MW AND LARGER

The interconnection customer'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, Midwest ISO, 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.

6. SYNCHRONIZATION OF INTERCONNECTION CUSTOMER'S GENERATION

All interconnection customers, independent of generator size classification, are responsible for synchronization of interconnection customer's generation to the WMU Bulk Electric System. Before synchronization to the WMU Bulk Electric System will be permitted, all required studies, tests and inspections, and contracts must be completed and approved.

A. END-USER INTERCONNECTION

Interconnection customer's that represents end-user load connecting to the WMU Bulk Electric System must adhere to the applicable sections of this document. Any remote control that is required will be implemented through the telemetry equipment identified in Section VIII.

B. TRANSMISSION INTERCONNECTIONS

Interconnection customer's that represents a transmission connection from another transmission owner to the WMU Bulk Electric System must adhere to the applicable sections of this document. Any remote control or indication that is required will be implemented through the telemetry equipment identified in Section VIII.

VI. REGIONAL ENTITIES COORDINATION

A. COORDINATION OF STUDIES

An Interconnection customer will be required to submit an interconnection application for any new or materially modified Facility it seeks to interconnect to the WMU Bulk Electric System. Depending on the size, type, and location of a new or materially modified Facility, a study could be performed by either: (1) WMU; or (2) the Midwest ISO; or (3) the Applicable Reliability Council; or (4) GRE the local balancing authority and neighboring transmission operator or (5) a neighboring load serving entity. WMU will have a different role to ensure coordination of studies for either new or materially modified facilities depending on who performs the study.

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

1. WMU will develop a study scope for the evaluation of a new or materially modified facility and request participation of interested parties in an ad hoc study group (including neighboring transmission owners, the Midwest ISO, the Applicable Reliability Council, and neighboring transmission owners.
2. WMU will ensure the study scope include NERC Reliability Standards and applicable Regional, Power Pool, and WMU Bulk Electric System planning criteria and facility connection requirements[1] and in addition includes the necessary steady-state, short-circuit, and dynamics studies to evaluate system performance in accordance with Reliability Standard TPL-001[2].
3. WMU will perform a study of the new or materially modified facility to evaluate of the reliability impact of the new facilities and their connections on the interconnected transmission systems in accordance with the guidelines and directives of the study scope based on input from the ad hoc study group[3].
4. WMU 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.
5. WMU will develop a study report documenting study criteria, procedures, assumptions, system performance (results), conclusions and jointly developed recommendations for review by the ad hoc study group[4].
6. WMU 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.
7. Once consensus is reached among the members of the ad hoc study group, WMU will share the study report with the Interconnection customer and affected parties that did not participate in the ad hoc study group[5].

WMU shall retain its documentation (of its evaluation of the reliability impact of the new or materially modified facilities and their connections on the interconnected transmission systems) for three years.

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

1. WMU will seek involvement to participate in an ad hoc study group for new facilities

[1] FAC-002-2 R1.2
[2] FAC-002-2 R1.3
[3] FAC-002-2 R1.1
[4] FAC-002-2 R1.4
[5] FAC-002-2 R1.4

proposing to interconnect to the WMU Bulk Electric System or for existing facilities proposing to be materially modified.

2. WMU will strive to ensure that the study assumptions and procedures are inclusive with those proposed by the party performing the study are detailed enough to determine if new facilities will meet facility connection requirements of WMU.
3. WMU will ensure that criteria are met to maintain acceptable system reliability on the System based on the requirements of WMU.
4. WMU 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. WMU will review study reports and provide comments, as necessary, to ensure that a new facility (or material modification of an existing facility) is not degrading the reliability of the System.

B. NOTIFICATIONS OF MODIFICATIONS

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

1. Schedule an internal meeting within WMU to gather personnel from all impacted areas (Planning, Operations, Engineering, Relaying, Substations, Communications, etc…)
2. Integrate the system change into the applicable models (MISO real-time network and commercial models, MISO planning model, MRO planning model, WMU state estimator (SE) model, etc…)
3. Depending on the magnitude of the new or materially modified facility, inform the Midwest ISO, the Applicable Reliability Council, neighboring transmission owners, neighboring load serving entities, and neighboring distribution providers through MISO Sub regional Planning Meetings (SPM) and insert (as appropriate) into the MISO Transmission Expansion Plan (through insertion into MTEP Appendices A, B, or C).

IV. VOLTAGE LEVEL AND MW AND MVAR CAPACITY OR DEMAND AT POINT OF CONNECTION

Any Interconnection customer interested in interconnecting to the WMU Bulk Electric System must complete an interconnection application. 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 materially modified) facility.

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

VI. BREAKER DUTY AND SURGE PROTECTION

At a minimum, the Interconnection Customers must follow ANSI / IEEE Std C37.90.1-1989 (R1994), IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

Also, please refer to section VII.A.4 for fault criteria and section X.A and X.B for surge requirements.

VII. PROTECTION REQUIREMENTS

At a minimum, the Interconnection Customers must follow the applicable ANSI/IEEE Guide:
ANSI/IEEE C37.91, Guide for Protective Relay Applications to Power Transformers
ANSI/IEEE C37.95, Guide for Protective Relaying of Utility-Customer Interconnections
ANSI/IEEE C37.97, Guide for Protective Relay Applications to Power System Busses
ANSI/IEEE C37.101, Guide for Generator Ground Protection
ANSI/IEEE C37.102, Guide for AC Generator Protection
ANSI/IEEE C37.106, Guide for Abnormal Frequency Protection for Power Plants
ANSI/IEEE Std 1001, Guide for Interfacing Dispersed Storage and Generation Facilities with Electric Utility Systems
ANSI / IEEE Std C37.90.1-1989 (R1994), IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

A. FOR ALL INTERCONNECTIONS

An important objective in the interconnection of facilities to the WMU'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 WMU Bulk Electric System. No new or materially modified facility on the WMU Bulk Electric System should degrade the existing WMU protection and control schemes or lower the levels of safety and reliability to other customers.

WMU's minimum protection requirements are designed and intended to protect WMU's system only. Neither party should depend on the other for the protection of its own equipment. WMU shall assume no liability for damage to interconnection customer-owned Facilities resulting from miscoordination between the interconnection customer's protective device(s) and WMU's protective devices. It is the interconnection customer's responsibility to protect its own system and equipment.

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

- Type and size of the interconnection customer's interconnecting equipment.
- Location of the interconnection customer on the WMU Bulk Electric System.
- Manner in which the installation will operate (one-way vs. two-way energy flow).

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

WMU shall operate all WMU-owned protective equipment at the interconnection to ensure that the protection and control requirements and objectives are met. During the interconnection process, WMU will approve the proposed type of interconnection protective devices, ownership, operating details and equipment settings. WMU is not liable or responsible for protection of the interconnection customer's facilities.

1. Disconnect

The disconnecting equipment shall be National Electrical Manufacturers Association (NEMA) approved for the specific application and location.

A manual disconnect device shall be installed to isolate the WMU Bulk Electric System from the interconnection customer's Facility. 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 WMU Bulk Electric System. A breaker that can be racked out into a visibly open position is also acceptable.

Please refer to section IX for Switching, Grounding and Safety Issues.

2. Protective Relay Requirements

Protective relays are required to promptly sense abnormal operating or fault conditions and initiate the isolation of the faulted area. All Generation, Tie-line and Substation Interconnections shall use utility grade relays. Protective relay settings on interconnect breakpoints must be approved by WMU.

WMU 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 is affected by any outage. Fault-interrupting equipment should usually be located at the Point of Interconnection or as close to the Point of Interconnection 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 WMU. Additional protective relays needed to adequately protect the Generation Facility must, at a minimum, meet IEEE Standards C37.90, C37.90.1, and C37.90.2. Interconnection customers shall submit complete control and relaying documentation that pertains to protection of the WMU Bulk Electric System.

Tables 1 and 2, later in this section, provide protective device recommendations necessary to protect WMU 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 interconnection customers as determined by WMU on a case-by-case basis. Generator protection may depend upon the size of the generator, location and nature of interconnection and coordination requirements with WMU protective systems or state interconnection requirements. All necessary protective requirements will be identified and an evaluation of any new or materially modified 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 WMU Bulk Electric System under a fault condition. 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 WMU tie breaker may be tripped.

4. Generation Protection

Generation relays must coordinate with the protective relays at the WMU breakers for the substation on which the interconnection customer's Facility is connected.

Table 1. Basic Generation Protection Devices (Protection Needs to be redundant for all interconnections at 69 kV and above.

Generator Protection Device	**Device Number**	**1 Mw or Less**	**1 MW and Larger**
Phase Overcurrent	50/51	X	X
Differential	87		X
Overvoltage	59	X	X
Undervoltage	27	X	X
Overfrequency	81O	X	X
Underfrequency	81U	X	X
Ground Over Voltage (ground fault protection for ungrounded system at the interconnection customer's end)	59G	TBD	TBD
Synchronizing and Reclosing Relays	25	TBD	TBD
Ground Fault Sensing Scheme	51N	X	X
Overcurrent With Voltage Restraint/Voltage Control or Impedance Relay	51V 21	X	X
Reverse Power Relay	32	X	X
Out of Step	68	TBD	TBD

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

5. Transmission Protection

Transmission Line protection relays must coordinate with the protective relays at the WMU breakers for the line on which the interconnection customer'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.

In coordinating a multi-terminal scheme, WMU may sometimes require installation of a transmission line protective relay at the interconnection customer's substation site. Because this line relay participates in a scheme to protect the WMU Bulk Electric System, WMU must ensure the maintenance, testing and reliability of this particular type of relay.

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. Existing relay schemes may have to be reset, replaced, or augmented with additional relays at the interconnection customer's expense, to coordinate with the interconnection customer's Facility.

The WMU Bulk Electric System required relays must be located so that a fault on any phase of the WMU line shall be detected. If transfer trip protection is required by WMU, the interconnection customer 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.

Table 2 lists the minimum protection that WMU requires for any new transmission 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 may be subject to state interconnection requirements. The acceptability and additional requirements of these interconnection requests shall be determined by WMU on a case-by-case basis.

Table 2. Basic Line Protection Devices (Protection Needs to be redundant at 115 kV and above for all interconnections. For lower voltage interconnections redundancy is only required for some specific areas of the System.)

Generator Protection Device	**Device Number**	**Less than 41.6 kV**	**41.6 kV to 69kV**	**115 kV**	**230 kV and above**
Phase Overcurrent (Radial systems)	50/51	X	X		
Ground Overcurrent (Radial systems)	50/51N	X	X		
Phase Directional Overcurrent	67		X[1]	X	
Ground Directional Overcurrent or Transformer Neutral	67N 50/51N		X[1]	X	X
Distance Relay Zone 1	21Z1			X[1]	X
Distance Relay Zone 2	21Z2			X[1]	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 WMU circuit configuration and loading,

as determined by WMU. 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.

6. End-User Protection

End-User relays must coordinate with the protective relays at the WMU breakers for the substation on which the interconnection customer's facility is connected. Faults within the interconnection customer's system (beyond interconnecting transformer) shall require fault interruption by the WMU protective equipment. If the interconnection customer's system has synchronously connected generation or is normally looped to other fault sources, the protection systems at the point of customer's interconnection may be classified as transmission Protection Systems under NERC PRC-005. If this classification occurs, then these systems will be subject to compliance with the NERC PRC standards and subject to transmission protection provisions of this document.

7. FAULT CURRENT

The combined available fault current of the WMU Bulk Electric System and the interconnection customer's facilities must not overstress WMU equipment. The interconnection customer shall provide any necessary provisions to satisfy this requirement. The designed maximum available fault current on the WMU Bulk Electric System is site specific.

Protective equipment on the WMU Bulk Electric System is specified within these limits. If the installation of interconnection customer-owned equipment causes these fault current limits to be exceeded, the interconnection customer must install equipment to limit the fault current on the WMU delivery system or compensate WMU 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 interconnection customer must work closely with WMU during the interconnection process to determine the available fault current at the specific location of interconnection.

8. Fault-Interrupting Devices

The fault-interrupting device selected by the interconnection customer must be reviewed and approved by WMU for each particular interconnection. WMU 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 WMU protection equipment.

There are two basic types of fault-interrupting devices:

a. Circuit Breakers

Ownership of the intertie circuit breaker will be determined during the interconnection process. However, WMU will have the operational authority to operate all intertie circuit breakers at all installations where the interconnection customer'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 interconnection customer's expense due to the increased fault current levels.

A three-phase circuit breaker at the Point of Interconnection automatically separates the interconnection customer's Facility from the WMU Bulk Electric System upon detection of a circuit fault. Additional breakers and protective relays may be installed in the interconnection customer'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.

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 WMU approval, some circuit switchers with blades can double as the visual open disconnect switch between the metering transformers and the main transformer.

9. Automatic Reclosing/Voltage Check Schemes

WMU normally applies automatic reclosing to all transmission and overhead distribution lines. Prior to automatic reclosing, the interconnection customer must ensure that the interconnection customer's Facility is disconnected from the WMU Bulk Electric System. It may be necessary to install voltage check schemes at various locations on the WMU Bulk Electric System to prevent automatic reclosing in the event that an interconnection customer's Facility remains connected to an isolated, unfaulted section of the WMU Bulk Electric System. These voltage check schemes may be located at the Point of Interconnection, at automatic circuit reclosers on the line feeding the interconnection customer, or on an WMU source substation feeder breaker. Any modifications to WMU reclosing practices and/or addition of voltage check schemes will be determined during the evaluation of any new interconnection.

In general, reclosing practices should be as follows:

- There should be no automatic reclosing for the incoming breaker.
- The WMU 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 WMU 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 WMU Bulk Electric System without damage to the unit.

1. Special Protection Scheme

The WMU Bulk Electric 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 WMU guidelines.

2. Event Recorder

All generation facilities with a rating greater than 50 MW must have an event recorder that will enable WMU 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 WMU Bulk Electric 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) and (5) record of deliveries to the WMU Bulk Electric System of real power in kW and reactive power in kVAr and output voltage in kV.

VIII. METERING AND TELECOMMUNICATIONS

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 output is less than station service.

Modifications to the revenue metering are usually required for any new interconnection. 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 bidirectional 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.

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. WMU'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-WMU 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. 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, WMU may request the interconnection customer to open the interconnection until the meter has been repaired.

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

3. Metering and Telemetry Function Requirements

The meter and telemetry requirements define WMU'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.

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

a) Additional Measured Values For Generating Stations With A Net Output Capacity Greater Than Or Equal to 1 MW

   i. Real Power Flow (Watts)
   ii. Reactive Power Flow (VArs), at WMU's discretion
   iii. Voltage at the Point of Interconnection to WMU Bulk Electric System (Volts), at WMU's discretion

b) Additional point for units requiring Telemetry Generating Stations with a net output capacity of 5 MW or greater

   i. Position (open/close) of generator breaker(s) and incoming and tie breakers (if present)
   ii. Remote Terminal Unit or Data Link to telemeter all measured values to WMU's SCADA System.

c) Measured Values and Metering Equipment Required For Transmission Interconnections that create a new boundary between Local Balancing Areas

i. bi-directional Real Power Flow (Watts)
ii. bi-directional Reactive Power Flow (VARs)
iii. Voltage at the Point of Interconnection to WMU Bulk Electric System (Volts), at WMU's discretion
iv. Interval Recorder to capture hourly energy use
v. Remote Terminal Unit or Data Link to telemeter all measured values to WMU's SCADA System.

d) Measured Values and Metering Equipment Required For Load Interconnections to Transmission System (non-parallel interconnection)

i. Real Power Flow (Watts)
ii. Reactive Power Flow (VARs)
iii. Interval Recorder to capture hourly energy use

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 back feed onto otherwise de-energized lines
- Providing information necessary for reliable operation of WMU equipment(feeders, substation, etc.) during normal and emergency operation
- Providing information necessary for the reliable dispatch of generation

Telemetry is required by WMU when:

- The possibility of islanding a portion of WMU's System exists
- 1 MW or larger generator
- The Facility plans to provide its own ancillary services.
- There is intent to sell power and energy over WMU Facilities.
- The Facility is required to meet the manual load shed requirement.
- 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 new 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 WMU 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)
- Interconnection customer load from WMU service (kW and kVAR)

When telemetry is required, the interconnection customer must provide the communications medium to WMU. If a telephone circuit is used, the interconnection customer must also provide the telephone circuit protection and coordinate the RTU addition with WMU.

C. COMMUNICATION CHANNEL

WMU 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 interconnection customer's Facility from the WMU Bulk Electric System due to a fault or other abnormal conditions that cannot be sensed by the protective devices at the interconnection customer's location. Some instances may require installation of communication equipment in WMU substations to initiate the protective signals. WMU shall be reimbursed by the interconnection customer 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 interconnection customer.

D. 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 WMU 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 69 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

IX. SWITCHING, GROUNDING AND SAFETY ISSUES (R3.1.7)

A. SAFETY AND ISOLATING DEVICES

At the Point of Interconnection to the WMU Bulk Electric System, an isolating device, which is typically a disconnect switch, shall be provided that physically and visibly isolates the WMU Bulk Electric System from the interconnection customer'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 WMU and may be under WMU Bulk Electric System Operator jurisdiction.
- Be lockable in the open position by WMU.

- 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.

WMU may require the design to allow the application of safety grounds on the WMU side of the disconnect (or breaker). OSHA lockout/tag requirements must be followed.

The disconnect (or breaker) must be accessible at all times to WMU personnel. Disconnects should allow for padlocking in the open position with standard WMU padlock. The interconnection customer shall not remove any padlocks or WMU safety tags. The disconnect (or breaker) should be located outside of the building if possible. If not possible, interconnection customer 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.

WMU 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 WMU equipment presents a hazardous condition.
- The interconnected Facility interferes with the operation of the WMU Bulk Electric System.
- The WMU Bulk Electric System interferes with the operation of the interconnected Facility.

B. ENERGIZATION OF WMU EQUIPMENT BY THE INTERCONNECTION CUSTOMER

No interconnection customers, independent of interconnection type or generator size, shall energize a de-energized WMU circuit. The necessary control devices shall be installed by the interconnection customer on the interconnection customer's Interconnection Facilities to prevent the energization of a de-energized WMU circuit. Connection may be accomplished only via synchronization with the WMU Bulk Electric System. All interconnecting circuit breakers/devices and all breakers/devices that tie another source to the WMU Bulk Electric System will require synchro-check relaying, other than quick open transition (break before make) transfer switch installations.

C. SUBSTATION GROUNDING

The interconnection customer shall submit the grounding system study and design for WMU review and approval. At a minimum, the Interconnection Customers must follow IEEE80 and IEEE 142 Standards

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. WMU must approve any connection to a WMU 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.

X. INSULATION AND INSULATION COORDINATION

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 WMU Bulk Electric System availability, reliability, equipment insulation margins, and safety. At a minimum, the Interconnection Customer must follow Standards IEEE C62.41 and IEEE C37.90.1 V&I Basic Insulation Level (BIL) ratings for electric system additions and electric system interface equipment.

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 WMU'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.

WMU highly recommends the interconnection customer 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 WMU's facilities from surge voltages. In general, all WMU incoming lines shall be protected with surge arresters located on the line side of the disconnect switch. All lines connecting to a WMU substation shall include either rod gaps or surge arresters for substation entrance protection. WMU 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 WMU 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, WMU 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.

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 WMU Bulk Electric System may fall within the voltage range shown on Table 3.

XI. VOLTAGE, REACTIVE POWER, AND POWER FACTOR CONTROL

A. VOLTAGE

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

For interconnections to the transmission system (generally at or above 69kV), voltage levels ± 10 percent from normal can be expected. If the interconnection customer's equipment cannot operate within the above range shown in Table 3, the interconnection customer may need to provide regulation equipment to limit voltage level excursions.

Table 3 – Voltage Limit on the WMU Bulk Electric System

	Low Voltage Limit	**High Voltage Limit**
Normal Operating Conditions	0.97 p.u.	1.05 p.u.
Emergency Operating Condition	0.90 p.u.	1.10 p.u.
Transient Condition	0.70 p.u.	1.20 p.u.

Consistent with the system performance criteria and technical study guidelines, the WMU Bulk Electric System is designed to avoid experiencing transient voltage dips below 0.70 p.u. due to external faults or other disturbance initiators. The interconnection customer should allow sufficient dead band in its voltage regulation equipment control to avoid reacting to transient voltage dips.

If the design of the interconnection customer'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 interconnection customer will generally be expected to provide for its own reactive power requirements.

1. Substation-Specific Power Factor Requirements

The WMU Transmission System is designed and operated assuming the power factor at the transmission side of the distribution transformer is 98 percent lagging 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 WMU Bulk Electric System deviates from the voltage range described in Section X.A., WMU will survey the interconnected substation(s) believed to be contributing to the voltage concern and the interconnection customer may be asked to demonstrate, (either by metered values or by inventory of installed equipment) that the interconnection customer meets its reactive power obligation. Any deviations are required to be corrected immediately.

2. Generator-Specific Power Factor Requirements

Generators connecting to the WMU Bulk Electric System will be expected to provide sufficient facilities and controls to operate their generation within a range of ± 95 percent power factor at the Point of Interconnection. The voltage set point that the generator needs to maintain will be established and adjusted as necessary by WMU'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.

Interconnection customers 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. Excitation Requirements

Please see Excitation Requirements in Section XVI.

XII. POWER QUALITY IMPACTS

A. FLICKER

Neither Party's facilities shall cause excessive voltage flicker nor introduce excessive distortion to the sinusoidal voltage or current waves as defined by ANSI Standard C84.1-1989, in accordance with IEEE

Standard 519, or any applicable superseding electric industry standard. In the event of a conflict between ANSI Standard C84.1-1989, or any applicable superseding electric industry standard, ANSI Standard C84.1-1989, or the applicable superseding electric industry standard, shall control.

Evaluation of a new or materially modified interconnection may involve a study to determine the reliability impacts on the WMU Bulk Electric 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.

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

B. HARMONICS

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. 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 interconnection customer's interconnecting equipment shall not introduce excessive distortion to the WMU Bulk Electric System's voltage and current waveforms per IEEE 519-1992.

The harmonic distortion measurements shall be made at the Point of Interconnection between the interconnection customer and the WMU Bulk Electric System and shall be within the limits specified in the tables below. WMU advises the interconnection customer to account for harmonics during the early planning and design stages of any interconnection project.

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 interconnection customer. These are often related to Facility grounding, and to the type of transformer connections that may be involved. It is to the interconnection customer's advantage to work these problems out early enough so that interconnection customer and WMU equipment can be acquired to achieve proper control.

XIII. EQUIPMENT RATINGS

A. GENERATION INTERCONNECTIONS

For interconnected generation that meets the NERC registration criteria must comply with the NERC FAC-008 standard for Facility Rating. Under this standard, the interconnection customer must develop a Facility Rating Methodology (FRM) that addresses the elements that comprise the generating Facility. The interconnection customer must make that FRM available to WMU upon request.

Through the course of the interconnection process, WMU shall provide the Facility Ratings Methodology upon request of the Interconnection customer. In determining the appropriate equipment ratings of interconnection customer-owned Facilities, the interconnection customer must consider manufacturer

specifications in the development of normal and emergency rating of each element comprising the Facility.

If the interconnection customer and WMU each own elements that comprise the generating Facility, then the generating Facility will be consider jointly for purpose of compliance with FAC-008. For a jointly owned generating Facility each party will share with the other the rating of their respective elements comprising the generating Facilities. Each parties shall use the most limiting element rating in determining the rating of the jointly owned generating Facility.

B. TRANSMISSION INTERCONNECTIONS

Interconnected transmission Facilities of 100kV or greater must comply with the NERC FAC-008 - standard for Facility Rating. Under this standard the interconnection customer must develop a Facility Rating Methodology (FRM) that addresses the elements that comprise the transmission Facility. The interconnection customer must make that FRM available to WMU upon request.

Through the course of the interconnection process, WMU shall provide the Facility Ratings Methodology upon request of the Interconnection customer. In determining the appropriate equipment ratings of interconnection customer-owned Facilities, the interconnection customer must consider manufacturer specifications in the development of normal and emergency rating of each element comprising the Facility.

If the interconnection customer and WMU each own elements that comprise the transmission Facility, then that transmission Facility will be consider jointly for purpose of compliance with FAC-008. For a joint own transmission Facility each party will share with the other the rating of their respectively elements comprising the generating Facilities. Each parties shall use the most limiting element rating in determining the rating of the jointly own generating Facility.

Upon the Interconnection customer's discretion and review of the WMU facility ratings methodology, the Interconnection customer shall provide Facility ratings to WMU for the Interconnection customer-owned equipment associated with the interconnection.

A. END USER INTERCONNECTIONS

The Interconnection customer and WMU must work closely during the interconnection process. Upon WMU acceptance of a valid interconnection application, the Interconnection customer must provide sufficient information to WMU 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, WMU shall provide the Facility Ratings Methodology (on file within WMU) to the Interconnection customer. The Interconnection customer shall review the WMU Facility Ratings Document to understand WMU's methodology of determining the appropriate equipment ratings.

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

WMU and the Interconnection customer shall jointly review their respective equipment and determine the most limiting equipment associated with the interconnection. The most limiting equipment (whether owned by the Interconnection customer or WMU) 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 WMU rating guidelines, which are established to meet NERC compliance. Equipment shall also meet applicable ANSI and/or IEEE standards.

XIV. SYNCHRONIZING OF FACILITIES

A. SYNCHRONIZING RELAYS

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

- Automatic synchronization with automatic synchronizing relay (Device 25) to synchronize with the WMU Bulk Electric 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 WMU Bulk Electric 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

Interconnection customers that own transmission Protective Systems and generating Protective Systems that meet the NERC registration criteria must develop and implement a Protective Maintenance Program that

complies with the NERC PRC standards.

Interconnection protective devices owned by the interconnection customer (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
- P-Ts,
- Fuses,
- Switches,
- SCADA Equipment Metering

WMU maintains the right to review maintenance, calibration and operation data of all protective equipment for the purpose of protecting WMU facilities and other WMU customers. The interconnection customer 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 WMU performs work on the interconnection customer's premises, an inspection of the work area may be made by WMU. If hazardous working conditions are detected, the interconnection customer will be required to correct the unsafe conditions before WMU will perform the work.

XVI. OPERATIONAL ISSUES

At WMUs discretion, the interconnection customer will supply, at its expense, an operating study and any required operating guides completed in coordination with WMU, Midwest ISO, the Applicable Reliability Council, and impacted transmission operators and balancing authorities. This would be required before energization of the Facility and must be updated as required. This operating study may result in operating guides.

A. OPERATING GUIDELINES

The interconnection customer shall operate its equipment within the guidelines of this handbook and any special requirements set forth by executed agreements with WMU.

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

- WMU is performing hot line maintenance work on the WMU Bulk Electric System.
- WMU Bulk Electric System emergency. Inspection of the interconnection customer's equipment and protective equipment reveals a hazardous condition.
- Failure of the interconnection customer to provide maintenance and testing reports when required.
- The interconnection customer's equipment interferes with other customers or with the operation of the WMU Bulk Electric System.

- The interconnection customer has materially modified the equipment or protective devices without the knowledge or approval of WMU.

- Operation, by interconnection customer, of any unapproved interconnection equipment. Personnel safety is threatened. Failure of the interconnection customer to comply with applicable OSHA Safety Tagging and Lockout requirements as well as Midwest ISO, Applicable Reliability Council, and WMU switching guides and safety standards or any successor agency assuming or charged with similar responsibilities.

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

Changes to the WMU Bulk Electric 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 interconnection customer may be subject to future charges for these modifications.

Operating criteria have been defined for interconnection customer Facilities interconnecting with the WMU Bulk Electric System in order to minimize adverse operating conditions to customers on the WMU Bulk Electric 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. 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 WMU 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.

C. GENERATOR FREQUENCY/SPEED CONTROL

1. 10 MW or Less

All interconnection customer generating equipment shall be designed to operate between 59.5 and 60.5 hertz. The operating frequency of the interconnection customer'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 WMU Bulk Electric System within 0.2 seconds if the frequency cannot be maintained within 0.5 hertz.

2. 10MW or Greater

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

a. Interconnection customer 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 WMU. The frequency relays must also be coordinated with WMU and the Applicable Reliability Council or Midwest ISO Under-Frequency Load Shed Plan. To ensure "ride-through" capability of the WMU Bulk Electric System, the interconnection customer shall implement an under-frequency relay set point for the Facility no greater than 58.5 Hz.

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, WMU may grant an exemption for generation Facilities that have excitation systems not meeting these requirements

XVII. INSPECTION REQUIREMENTS FOR EXISTING OR NEW FACILITIES

A. INSPECTION, TEST, CALIBRATION AND MAINTENANCE

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

The interconnection customer 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.

XVIII. COMMUNICATIONS AND PROCEDURES DURING NORMAL AND EMERGENCY OPERATING CONDITIONS

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

The interconnection customer shall also arrange to get real-time SCADA data to the Midwest ISO according to the Midwest ISO protocols and data compatibility requirements. The interconnection customer may choose to utilize WMU to perform this responsibility.

A. DISPATCHING AND MAINTENANCE

WMU 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 WMU 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 interconnection customer shall adhere any load shedding directives by WMU and coordination of load restoration with WMU.

   The tie-line interconnection customer must make its facilities available to WMU during emergencies as far as physically possible.

   The generation interconnection customer shall make its generation available and adhere to reliability directives regarding the real or reactive output and on or off line status in compliance with the NERC standards. Unless the generator is out for maintenance or due to mechanical failure, the interconnection customer must be able to bring the unit to full output within the time specified in the emergency offer to the Midwest ISO. Failure to respond in a timely manner may result in financial penalties if such financial penalties are assessed by Midwest ISO 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 WMU.

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 interconnection customer. The station service requirements of the new Facilities, including voltage and reactive requirements shall not impose operating restrictions on the WMU Bulk Electric System beyond those specified in applicable NERC, Midwest ISO, 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 interconnection customer 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. Lighting

Substation lighting shall meet the requirements of the NESC. Controls for yard and control house lighting shall be accessible to WMU at all times. WMU standards for lighting are available upon request.

XX. REVISION HISTORY

Rev	Change	Revised by	Reviewed By	Authorized By:	Reviewed Date: Issued Date: Effective Date:
0	Development of Policy	W. Hompe	W. Hompe	W. Hompe	08/27/2010
1.0	Review, reformat, edit, remove MAPP and add revision history	J. Johnson	Jeron Smith	W. Hompe	08/23/2013 12/27/2013 12/30/2013
2.0	Review, update requirement numbering for FAC-001-1, reformat header	Janell Johnson	Jeron Smith	Wes Hompe	12/26/14 12/26/14 12/30/14
2.0	Annual Review No Changes	Janell Johnson	Jeron Smith	Wes Hompe	12/15/15 12/17/15 01/20/16
3.0	Annual Review – Added Materially Modified 18 references, removed requirement references	Janell Johnson	Jeron Smith 12/2/2016	John Harren	1/26/16 12/2/16 12/28/16
3.0	Annual Review – No Changes	Janell Johnson	Jeron Smith	John Harren	12/27/2017 12/28/2017 12/28/2017
3.0	Annual Review – No Changes confirm R3 3.3 complies in 2 E.	Janell Johnson	Dave Andrist/Jeron Smith	John Harren	12/03/2018 12/12/2018 12/21/2018