FACILITY INTERCONNECTION REQUIREMENTS
Effective 1/1/2016

1. PURPOSE

To avoid adverse impacts on the reliability of the Bulk Electric System (BES), SMMPA documents and makes Facility interconnection requirements (Requirements) available so that entities seeking to interconnect will have the necessary information. These Requirements are compliant with NERC Standard FAC-001-2 Facility Interconnection Requirements. [FAC-001-2 R1]

2. APPLICABILITY

These Requirements address interconnection requirements for:

2.1. generation Facilities [FAC-001-2 R1, 1.1]

2.2. transmission Facilities; and [FAC-001-2 R1, 1.2]

2.3. end-user Facilities [FAC-001-2 R1, 1.3]

3. DEFINITIONS

3.1. **Facility**
A set of electrical equipment that operates as a single Bulk Electric System Element (e.g., a line, a generator, a shunt compensator, transformer, etc.)

4. FACILITY INTERCONNECTION REQUIREMENTS [FAC-001-2 R1]

SMMPA is a transmission-owning member of the Midcontinent Independent System Operator, Inc. (MISO) for Planning Authority services. MISO is responsible for the coordination of studies of new or materially modified existing interconnections. As the Transmission Provider, MISO administers the interconnection process.

SMMPA utilizes multiple Transmission Operators (TOP) to operate and maintain its transmission Facilities. The TOP sets the requirements necessary to support operation and maintenance of the transmission Facilities at the point of interconnection.

As the Transmission Owner, SMMPA sets the technical standards that must be met by an interconnection customer when interconnecting new or materially modified existing interconnections to the SMMPA transmission Facilities.

These Requirements describe SMMPA's requirements for the interconnection of new or materially modified existing generation Facilities, transmission Facilities, or end-user Facilities to the transmission Facilities owned by SMMPA. These Requirements are intended to supplement and be consistent with the requirements

of MISO and the applicable TOP. The interconnection customer must also comply with the requirements of the following authorities:

- State and federal laws, rules and regulatory requirements
- North American Electric Reliability Corporation ("NERC")
- Midwest Reliability Organization ("MRO")

These Requirements are not intended to modify or supersede the requirements of MISO, the applicable TOP, or any authority noted above. All interconnection customers are required to comply with the relevant requirements of SMMPA, MISO, the applicable TOP, and any authority noted above. It is the interconnection customer's responsibility to work closely with SMMPA, the applicable TOP, MISO, and others to ensure compliance with all applicable interconnection requirements.

These Requirements may not address every situation an interconnection customer may encounter. It is the responsibility of the interconnection customer to consult with SMMPA when in doubt as to the applicability of any requirement. Exceptions to these Requirements will be considered on a case-by-case basis. These Requirements shall not be construed as modifying or superseding any existing agreement between SMMPA and the interconnection customer.

4.1. Procedure for Coordinated Studies [FAC-001-2 R3, 3.1]

SMMPA participates in the MISO planning process. The interconnection customer requesting new or materially modified existing interconnections of generation Facilities, transmission Facilities, or end-user Facilities is responsible for cooperating with SMMPA and MISO and participating in the MISO planning process to determine their impacts on affected system(s).

4.2. Procedure for Notifications [FAC-001-2 R3, 3.2]

The interconnection customer requesting new or materially modified existing interconnections of generation Facilities, transmission Facilities, or end-user Facilities is responsible for notifying SMMPA well in advance of any interconnection. SMMPA will assess the potential impact of the interconnection on the affected system(s) and contact the applicable parties. Interconnections that have the potential to impact the reliability of the affected system(s) will be forwarded to the Reliability Coordinator (MISO RC) prior to completing the interconnection.

4.3. Voltage Level and MW and Mvar Capacity or Demand

After the requester supplies SMMPA with the approximate geographic location and the desired megawatt (MW) and megavolt-amp reactive (Mvar) capacities at the point of interconnection, SMMPA will exercise engineering judgment and utilize the results of engineering studies to determine appropriate voltage levels, interconnection points, and system capabilities, since the most practical voltage and interconnection points are site and project-specific.

4.4. Breaker Duty—Surge Protection

All Facilities and equipment must equal or exceed the fault duty capability necessary to meet system short-circuit requirements as determined through short-circuit analyses and should fully comply with the latest American National Standards Institute (ANSI)/Institute for Electrical and Electronics Engineers (IEEE) C37 collection of standards for circuit breakers, switch gear, substations and fuses.

In order to maintain transmission reliability, each fault-interrupting device must be rated for full fault interrupting capability to satisfy short-circuit level requirements at the point of interconnection. Full fault interrupting capability is per the latest IEEE C37 and C57 collections of standards. As a general rule, neither party should depend on the other for the protection of their respective equipment.

4.5. System Protection and Coordination

Protective Relaying

Protective relaying systems and associated communications systems for all Facility interconnections shall be planned, designed, constructed, and maintained in accordance with applicable NERC and MRO standards. Utility grade protective relays and fault clearing systems are to be provided on the interconnected power system. All protective relays shall meet or exceed ANSI/IEEE Standard C37.90. Adjoining power systems may share a common zone of protection between two parties. The design must provide coordination of speed and sensitivity in order to maintain power system security, stability, and reliability. The Facility owner shall provide documentation showing all applicable Facility ratings and impedance data to SMMPA to support coordination of protection systems.

The protection system (relay, control, and communications equipment) arrangement selected by the requester must be compatible with the protection system used by SMMPA to protect the transmission grid. Compatible relaying equipment must be used for a given zone of protection. Compatibility includes protection application, redundancy, operating speed, communication type and communication medium.

A power source for tripping and control must be provided for the protection system by a DC storage battery system. The battery bank is to be sized with enough capacity to operate all tripping devices after twelve hours without a charger, per IEEE standards. An under voltage alarm and DC ground alarm must be provided for remote monitoring by the Facilities owners, who shall take immediate action to restore power to the protective equipment.

Mechanical and electrical logic and interlocking mechanisms are required between interconnected Facilities to ensure safe and reliable operation. These include, but are not limited to, breaker and switch auxiliary contacts, synch-check relays, and physical locking devices.

The Facility owner (generator, transmission, and end-user) is responsible for providing a protection system that will protect its equipment against disturbances on transmission system and minimize the effects of disturbances from its Facilities on SMMPA's equipment and the transmission system. Entities connecting to the SMMPA transmission system shall investigate and keep a log of all protective relay actions and misoperations, as required by NERC and MRO. In addition, the interconnecting entities must have a maintenance program, compatible with and meeting NERC standards for their protection systems in accordance with MRO. Documentation of the protection maintenance program shall be supplied to SMMPA, MRO, and NERC upon request. As outlined in the maintenance program, test reports are to be made available for review by SMMPA. At intervals described in the documented maintenance program and following any apparent malfunction of the protection equipment, the entity shall perform both calibration and functional trip tests of its protection equipment as outlined by MRO.

Generator Protection Requirements

Generators connecting to the SMMPA transmission system are responsible for protecting those Facilities from electrical faults and other hazardous conditions. Generator interconnections must be equipped with circuit breakers or other appropriate interrupting devices to protect those Facilities. The generator owner must provide and own the primary circuit breaker or other interrupting device that protects the Facility and disconnects it from the SMMPA transmission system. The primary purpose of this interrupting device is to protect the generating plant Facility.

Synchronous or wind turbine generators connected to the SMMPA transmission system shall be able to withstand certain temporary excursions in voltage, frequency, and reactive and real power output without tripping. A system impact study will determine if additional reactive devices are required to maintain the generation during the temporary excursions. Maintaining the generation is required to support the grid and avoid cascading events. Generation protection and control shall be set in accordance with all applicable MISO, NERC and MRO requirements to coordinate with excitation limiters.

It is recognized that certain circumstances may exist that necessitate the imposition of performance criteria that are considered more stringent than the default criteria specified above. Such circumstances shall be identified during the conduct of the system impact study or operational study for each particular generator.

Transmission Protection Requirements
All transmission power systems shall have a high-speed pilot primary relaying and a high-speed non-pilot secondary relaying scheme that provides backup coverage of the remote bus. Pilot communications redundancy may be required depending on critical clearing time. A transfer trip scheme is required for backup protection. Synchronism check relaying is required. Line reclosing is required.

Backup protective systems should provide additional coverage for breaker and relay failure outside the primary zone. Specific breaker failure protection schemes shall be applied as required to meet NERC requirements, and, where local/remote backup does not provide adequate sensitivity or speed, specific relay failure backup shall also be provided. Backup systems shall operate for failures on either side of an interconnection point. Time and sensitivity coordination must be maintained to prevent misoperations.

Fiber optics is the preferred means of relay communications; however, power line carrier may also be used.

Each fault-interrupting device must be rated for full fault-interrupting capability to satisfy short-circuit level requirements at the point of interconnection. Neither party shall depend on the other for the protection of their respective equipment.

4.6. Metering and Telecommunications

Energy Metering
At the requester's expense, SMMPA will specify, design, install, own, and maintain all energy metering and metering devices (including instrument transformers) used to measure the delivery and/or receipt of energy for payment purposes. Metering shall be required for each point of delivery where the requester's Facilities interconnect with SMMPA Facilities. Metering equipment should be placed as close to the point of delivery as practicable. Meter accuracy will be maintained within +/- 1.0%. SMMPA will test meters on an annual schedule; the requester will receive notification of test scheduling and copies of test results upon request. Requests for additional unscheduled testing will be honored at the expense of the requester unless the meters are found to be out of tolerance.

Typical metering requirements include the following:

- 15-minute load profile data for:
  - Kilowatt hour (kWh) delivered and/or received
  - Kilovolt amp reactive (kvar)—hours delivered and/or received

- Total accumulative registers for:
  - kWh delivered and/or received
  - kvar—hours delivered and/or received

Energy Metering Communications
The requester, at its expense, shall provide and maintain a voice telephone circuit at each point of delivery dedicated for the purpose of accessing SMMPA's dial-up energy metering equipment.

Supervisory Control and Data Acquisition (SCADA)
SMMPA may require a Remote Terminal Unit (RTU) or similar device for the purpose of gathering requester load and equipment status information needed at the applicable operations center(s). When required, SMMPA shall own and maintain the SCADA devices at the requester's expense. The requester shall provide, at its expense, a telecommunications data circuit to the operations center(s) designated by SMMPA. SMMPA shall specify the communications protocol for this data circuit(s). Instantaneous bi-directional analog real power and reactive power flow information must be telemetered directly to the location(s) specified by SMMPA.

Typical data requirements include the following:

- Status of interrupting devices
- MW flow
- Mvar flow
- Voltage at interconnection point

Equipment Enclosures
The metering, communications, and SCADA equipment shall be located within an equipment enclosure suitable for housing the equipment. At the requester's expense, SMMPA will specify, design, and install the equipment enclosures. SMMPA shall own and maintain the equipment enclosures.

4.7. Grounding and Safety Issues

A safe grounding design must accomplish two basic functions:

- Ensure that a person in the vicinity of grounded structures and Facilities is not exposed to critical levels of step or touch potential; and
- Provide a path for electric currents into the earth under normal and fault conditions without exceeding any operating and equipment limits or adversely affecting the continuity of service.

Accordingly, each electrical Facility must have a grounding system or grid that solidly grounds all metallic structures and equipment in accordance with the standards outlined in ANSI/IEEE 80, IEEE Guide for Safety in AC Substation Grounding, ANSI/IEEE C2, National Electrical Safety Code (NESC).

Testing must be performed to ensure safe step and touch potential parameters have been met in accordance with IEEE 80.

When various switching devices are opened on an energized circuit, its ground reference may be lost if all sources are not effectively grounded. This situation may cause over voltages that can affect personnel safety and damage equipment. This is especially true when one phase becomes short-circuited to ground. Therefore, the interconnected transmission power system is to be effectively grounded from all sources. Interconnected generators should provide for effective system grounding of the high-side transmission equipment by means of a grounded high-voltage generation step-up transformer.

Safety is of utmost importance. Strict adherence to established switching, tagging, and grounding procedures is required at all times for the safety of personnel. Any work carried out within a Facility shall be performed in accordance with all applicable laws, rules, and regulations and in compliance with Occupational Safety and Health Administration (OSHA), NESC, and good utility practice. Automatic and manual disconnect devices are to be provided as a means of removing all sources of current to any particular element of the power system. Only trained operators are to perform switching functions within a Facility under the direction of the responsible dispatcher or designated person as outlined in the NESC.

4.8. Insulation and Insulation Coordination

Insulation coordination is the selection of insulation strength. Insulation coordination must be done properly to ensure electrical system reliability and personnel safety. Basic switching surge levels (BSL), surge arrester, conductor spacing and gap application, substation and transmission line insulation strength, protection, and shielding shall be documented and submitted for evaluation as part of the interconnection plan.

Equipment basic impulse surge levels (BIL) shielding and surge protection shall be designed to meet the latest IEEE C62 standards.

4.9. Voltage, Reactive Power, and Power Factor Control

Generation Facilities

Refer to the MISO generator interconnection agreements for voltage, reactive power, and power factor control requirements for generators.

Transmission Facilities

The transmission system must be capable of moving electric power from areas of generation to areas of load under a wide variety of expected system conditions. Adequate reactive power supplies are of paramount importance to the capability of the transmission system to reliably support a wide variety of transfers. Transmission Facilities must be designed to minimize excessively high voltages during light transmission loading conditions, yet have adequate reactive supplies to support system voltage during heavy transmission loading conditions.

End-User Facilities
SMMPA strives to supply end-user Facilities with voltage that is +/- 5% from nominal. End-user Facilities connected directly to the transmission system should plan and design their systems to operate at or better than 98% power factor to minimize the reactive power burden on the transmission system.

4.10. Power Quality Impacts

Harmonic Levels

Generation Facilities
Generation Facilities shall not have harmonic current distortion levels exceeding the levels recommended in most recent revision of IEEE-519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems. Generation Facilities must meet the stated current limits specified for generators as presented in the Current Distortion Limits tables for the applicable voltage levels.

Generation Facilities shall not cause the harmonic voltage distortion levels to exceed the voltage distortion limits recommended in the most recent revision of IEEE-519.

Transmission Facilities
Transmission Facilities shall not have harmonic current distortions levels exceeding the levels recommended in the most recent revision of IEEE-519.

End-User Facilities
End-user Facilities shall not have harmonic current distortion levels exceeding the levels recommended in the most recent revision of IEEE-519. End-user Facilities must meet the stated current limits specified in the Current Distortion Limits tables for the applicable voltage levels.

Flicker

Transmission Facilities and End-User Facilities
Transmission Facilities and end-user Facilities are required to limit voltage fluctuations to the limits specified in the most recent revision of IEEE-1423.

4.11. Equipment Ratings

All circuit breakers and other fault-interrupting devices shall be capable of safely interrupting fault currents for any fault they may be required to interrupt. Application of circuit breakers shall be in accordance with the ANSI/IEEE C37 collection of standards.

All current-carrying equipment and devices shall be designed to carry the maximum loads that are predicted and used in load flow analysis. Loads

exceeding nameplate or normal design capacities are acceptable only when allowed by manufacturers' design documentation or standard industry practices.

Equipment BILs, shielding, and surge protective device application must meet requirements as determined by the latest IEEE C62 standards. Also, equipment must meet all applicable ANSI/IEEE standards and specifications communicated by SMMPA in pre-interconnection meetings.

4.12. Synchronizing of Facilities

General

Synchronizing Facilities consisting of potential transformers and associated protective relaying/controls are required at the point of interconnection on transmission Facilities where energy can be sourced on both sides of an interconnection circuit breaker. These Facilities verify that the voltages on both sides of a circuit breaker fall within certain tolerances of both magnitude and phase angle as established by system conditions, supervise the closing and automatic reclosing of the circuit breaker, and prevent the closing of the circuit breaker when the two systems are out of synchronism.

Voltage magnitudes, phase angles, and frequency constraints shall be determined on a case-by-case basis depending on system characteristics, conditions, interconnection location, etc.

Generation Facilities

Live line – dead bus (LLDB) control is used in the interconnection circuit breaker reclosing scheme when generation Facilities are connected to transmission Facilities. In summary, the circuit breaker cannot be closed unless the generation side has essentially zero voltage. The transmission Facility interconnection circuit breaker shall not be used to synchronize a generator to the transmission system. Instead, the generation Facilities shall have their own synchronizing Facilities to synchronize to the system. In addition, the generation Facility shall remain disconnected from SMMPA's system until system voltage and frequency are within an established range should a generation Facility become disconnected from SMMPA's system.

Transmission Facilities

Live line – dead bus (LLDB) and dead line – dead bus (DLDB) control is used in the interconnection circuit breaker reclosing scheme when transmission Facilities are interconnected to transmission Facilities. In summary, the circuit breaker cannot be closed unless the transmission sources on both sides of the open circuit breaker are essentially in phase. The transmission Facility interconnection circuit breaker shall not be used to synchronize a generator to the transmission system. Instead, the generation Facilities shall have their own synchronizing Facilities to synchronize to the system. In addition, the transmission Facility shall remain disconnected from SMMPA's

system until system voltage and frequency are within an established range should the transmission Facility become disconnected from SMMPA's system.

End-User Facilities
Live line – dead bus (LLDB) and dead line – dead bus (DLDB) control is used in the interconnection circuit breaker reclosing scheme when transmission Facilities are interconnected to transmission Facilities. In summary, the circuit breaker cannot be closed unless the transmission sources on both sides of the open circuit breaker are essentially in phase. The transmission Facility interconnection circuit breaker shall not be used to synchronize a generator to the transmission system. Instead, the generation Facilities shall have their own synchronizing Facilities to synchronize to the system. In addition, the transmission Facility shall remain disconnected from SMMPA's system until system voltage and frequency are within an established range should the transmission Facility become disconnected from SMMPA's system.

4.13. Maintenance Coordination

In accordance with NERC Reliability Standard TOP-003 Planned Outage Coordination, scheduled generator and transmission outages that may affect the reliability of interconnected operations must be planned and coordinated among the affected parties. Refer to Standard TOP-003 for the applicable requirements.

The maintenance of Facilities is the responsibility of the owner of those Facilities. Adjoining Facilities on the interconnected power system are to be maintained in accordance with accepted industry practices and procedures. Each party is to have a documented maintenance program ensuring the proper operation of equipment. SMMPA will have the right to review maintenance reports and calibration records of equipment that could impact the SMMPA system if not properly maintained. SMMPA is to be notified as soon as practicable about any out-of-service equipment that might affect the protection, monitoring, or operation of interconnected Facilities.

Maintenance of Facilities interconnected to the SMMPA transmission system shall be done in a manner that does not place the reliability and capability of the SMMPA transmission system, or other portions of the BES at risk. Planned maintenance must be coordinated and scheduled with SMMPA.

4.14. Operational Issues (Abnormal Frequency and Voltages)

Operational procedures are to be established in accordance with all applicable NESC, OSHA, MRO, and NERC requirements. Each party shall designate operating representatives to address the following:

- Lines of communications
- Maintenance coordination
- Actions to be taken after de-energization of interconnected Facilities

- Other required operating policies

All parties are to be provided with current station operating diagrams. Common, agreed-upon nomenclature is to be used for naming stations, lines, and switches. Updated diagrams are to be provided when changes occur to interconnected Facilities.

The operator of Facilities interconnecting to the SMMPA transmission system will not perform any switching that energizes or de-energizes portions of the SMMPA transmission system or that may adversely affect the SMMPA transmission system without prior notice to SMMPA or its designated operating representative. Operators of Facilities interconnecting to the SMMPA transmission system will notify SMMPA, or its designated operating representative, before performing any switching that would significantly affect voltages, power flows, or reliability in the SMMPA transmission system. During emergency conditions, the Facility operator shall raise or lower generation, adjust reactive power, switch Facilities in or out, or reduce end-user load as directed by the SMMPA grid operator.

4.15. Inspection Requirements for Existing or New Facilities

Each party to the interconnection agreement shall perform routine inspection and testing of its Facilities and equipment in accordance with good utility practice and regulatory requirements to ensure the continued interconnection of the Facilities with SMMPA's transmission system.

Each party shall, at its own expense, have the right to observe the testing of any of the other party's Facilities and equipment whose performance may reasonably be expected to affect the reliability of the observing parties' Facilities and equipment. Each party shall notify the other party in advance of Facility and equipment testing, and the other party may have a representative attend and be present during such testing. If a party observes any deficiencies or defects on—or becomes aware of a lack of scheduled maintenance and testing with respect to—the other party's Facilities and equipment that might reasonably be expected to adversely affect the observing party's Facilities and equipment, the observing party shall provide notice to the other party that is prompt under the circumstance, and the other party shall make any corrections required in accordance with good utility practices and as required by regulatory agencies. Where deficiencies or defects are not resolved in a reasonable and prompt manner, decisions will be made on a case by case basis whether the Facility may remain in operation. Decisions will consider severity of the deficiency or defect and the resulting impact to reliability.

4.16. Normal and Emergency Operating Conditions

Complete, precise, and timely communication is an essential element for maintaining reliability and security of a power system. Under normal operating conditions, the major link of communication with various

interconnects shall be by telephone lines. SMMPA and its requester shall maintain communications that shall include, but not be limited to:

- System paralleling or separation
- Scheduled or unscheduled shutdowns
- Equipment clearances
- Periodic load reports
- Maintenance schedules
- Tagging of interconnection interrupting devices
- Meter tests
- Relay tests
- Billing
- Other routine communication

In case of emergency or abnormal operating conditions, various communication channels may be used. Emergency telephone numbers should be agreed upon by both parties prior to the actual interconnection date.

5. REVISION AND AVAILABILITY [FAC-001-2 R1]

This document shall be maintained and updated as needed by SMMPA. This document shall be made available to entities upon request.

6. REFERENCES

NERC Reliability Standard FAC-001-2 Facility Interconnection Requirements

Document Approval / Review Information			
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