Generation Interconnection Guidelines
for the
Dairyland Power Cooperative
Transmission System
(new interconnections or materially modified existing interconnections)

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Dairyland Power Cooperative
3200 East Avenue South, P. O. Box 817
La Crosse, WI 54602-0817

DAIRYLAND POWER COOPERATIVE

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I) INTRODUCTION

Dairyland Power Cooperative (DPC) is a generation and transmission rural electric cooperative (G&T) that provides all wholesale electrical requirements and services for 24 member electric distribution cooperatives and 17 municipal utilities in the states of Minnesota, Wisconsin, Iowa, and Illinois.

DPC owns and operates a network of 161 kV and 69 kV transmission assets in the states of Minnesota, Wisconsin, Iowa, and Illinois (the DPC Transmission System[1]). The requirements stated in this guide are applicable for all generation facilities that interconnect to and operate in parallel with the DPC Transmission System.

a) Purpose

This Generator Interconnection Guide describes the minimum requirements for the connection of generation to the DPC Transmission System. Additional specific requirements will be identified during studies conducted in connection with the particular proposed generator interconnection project.

This document is intended to achieve the following:

- Provide comparable reliability and service to all users of the DPC Transmission System.
- Ensure the safety of the general public, DPC customers, and DPC personnel.
- Minimize any possible damage to the electrical equipment of DPC, DPC customers, and others.
- Minimize adverse operating conditions on the DPC Transmission System.
- Permit a generator owner to operate generating equipment in parallel with the DPC Transmission System in a safe, reliable, and efficient manner.
- Meet all applicable Federal Energy Regulatory Commission, North American Electric Reliability Corporation, Rural Utilities Service, Midwest Reliability Organization, and Midcontinent Independent System Operator planning requirements, operating standards, and regulations.

b) Transmission System Regulatory Overview

i) General

DPC, a generation and transmission owning rural electric cooperative, borrows funds from the US Department of Agriculture’s (USDA) Rural Utilities Service (RUS). As a RUS borrower, DPC is generally subject to the rules and regulations of

[1] The DPC Transmission System includes a limited quantity of 34.5 kV and 115 kV transmission assets that are subject to this Generation Interconnection Guide document.

the USDA RUS. This means that DPC is not subject to rate regulation by any other federal agency.

ii) Federal Energy Regulatory Commission

The Federal Energy Regulatory Commission (FERC) regulates public utility transmission, sales of electric energy at wholesale in interstate commerce, and reliability under the powers delegated to it by the Federal Power Act, (FPA).

As a RUS borrower, DPC is not considered a public utility subject to FERC rate regulation. However, under the Energy Policy Act of 2005, DPC is subject to the mandatory reliability and compliance standards that are administered by the FERC.

In the area of generator interconnection, FERC has issued several orders that are relevant to the industry, generation project developers, and transmission owners. Order 2003 covers all generation interconnections greater than 20 MW, Order 2006 covers all generation interconnections less than or equal to 20 MW, and Order 661 provides additional rules and procedures for wind energy and other alternative technologies. A generation project developer that seeks to interconnect its project to the DPC Transmission System should generally be familiar with these FERC Orders.

iii) Midcontinent Independent System Operator

The Midcontinent Independent System Operator (MISO) is a FERC approved Regional Transmission Organization (RTO). Under its Open Access, Energy and Operating Reserves Markets Tariff (MISO Tariff), MISO has functional control and tariff administration responsibility for all MISO member owned transmission assets greater than 100 kV within its footprint. MISO is also the Balancing Authority (BA), in which the interconnection entity must confirm the new or materially modified generation facilities are within the BA's metered boundaries.

DPC is a transmission owning member of MISO. Therefore, while DPC is generally non-FERC jurisdictional, by becoming a MISO transmission owning member, DPC is subject to all of the terms and conditions of the FERC approved MISO Tariff. As such, all DPC transmission assets greater than 100 kV fall under MISO functional control and tariff administration. DPC's transmission assets less than 100 kV are under an agency agreement with MISO. DPC transmission assets under the agency agreement are under DPC's functional control, but MISO acts as DPC's agent in the performance of tariff administration duties. Therefore, all generation interconnection requests to the DPC Transmission System are subject to the processes and procedures required by the MISO Tariff.

The MISO Tariff and associated Business Practice Manuals (BPM) define the requirements for generator interconnection requests to MISO member owned transmission facilities. The MISO process and procedures for generation interconnection request are found on the MISO website.
DPC strongly recommends that any generation project developer that wishes to interconnect a generating facility to the DPC Transmission System read and review MISO's generator interconnection information.

iv) North American Electric Reliability Corporation Reliability Standards

In June of 2007, FERC granted The North American Reliability Corporation (NERC) the legal authority to enforce reliability standards with all users, owners, and operators of the bulk electric system in the United States, and made compliance with those standards mandatory and enforceable. Under this delegation of power, NERC has established standards and practices for the reliable design and operation of the electric transmission system. NERC and the individual reliability regions under it modify and update these requirements from time to time. The reliability region that has authority for the DPC Transmission System is the Midwest Reliability Organization (MRO). The generation project developer should be familiar with NERC and the MRO to ensure that the most up-to-date requirements are used in its project's design, operation, and maintenance requirements.

c) Generator Interconnection to Distribution Level Voltages

i) DPC's Renewable Resources and Distributed Generation Policy

DPC and its member cooperatives have policies and procedures that apply to renewable and distributed generation projects. These policies and procedures are for requesting interconnections to a DPC member's distribution system. These policies are intended to establish an overall policy framework regarding the development and installation of distributed generation.

ii) Generator Owner Requesting Interconnection to a Distribution System

Each DPC member distribution cooperative will provide the technical requirements for distribution system generation interconnection requests to its system. The resulting interconnection agreement shall be between the generator owner and the DPC member distribution cooperative.

iii) Generator Owner Requesting Interconnection to DPC Owned Distribution Substation

DPC will provide the technical requirements for connections to DPC distribution substations at distribution voltage requests to its system. The resulting interconnection agreement shall be between the generator owner and DPC.

II) MISO INTERCONNECTION PROCESS

A generation project developer intending to interconnect new or materially modify existing generation with the DPC Transmission System must follow the MISO interconnection process as governed by the MISO Tariff and outlined on MISO's website. The specific MISO Tariff process is referred to as "Attachment X - Generation Interconnection Procedures (GIP)." The MISO Business Practices Manual for Generation Interconnection is BPM-015. These MISO documents are occasionally updated and it is the generation project developer's responsibility to check for the latest revisions.

MISO BPMs are found at the following web address (this URL address can change): https://www.misoenergy.org/legal/business-practice-manuals/

MISO and DPC will work with the generation project developer throughout the MISO GIP and study process. The MISO GIP and study process overview is as follows:

a) MISO GIP Overview

i) Pre-Queue

At the pre-queue phase of the process, the generation project developer shall educate themselves on the appropriate regulatory requirements and MISO Tariff procedure for a generator interconnection. Once the regulatory requirements and specific MISO Tariff procedures are understood, then the generation project developer shall submit a completed application form to MISO[2] providing all of the required information. MISO shall then notify DPC, as the applicable transmission owner, of the generator interconnection request. The MISO generation interconnection application is found at the following web address (this URL address can change): https://www.misoenergy.org/planning/generator-interconnection/.

ii) Application Review

In this phase, MISO will review the generator interconnection request and either clarify information on the request or deem the request complete. Once the request is deemed complete, including meeting applicable milestones and study deposits.

[2] While not required by the MISO GIP, it is recommended that the generator owner provide a copy of the application to DPC.

iii) Definitive Planning Phase (DPP)

The generation project developer shall provide the appropriate milestones and deposits, to move into the DPP of the GIP.

The DPP has three stages; three phases of system analysis, a Facilities Study, and the preparation and execution of a Generator Interconnection Agreement (GIA)[3].

The Facilities Study is an engineering report with scope, schedule, and cost estimates for design (including equipment ratings). The required Network Upgrades and new DPC Interconnection Facilities that physically and electrically interconnect the proposed generator to the DPC Transmission System are provided in the Facilities Study.

iv) Additional Information

The generation project developer should consult MISO BPM-015 for further details on milestones, scope, timeframe, and deposits for each of the interconnection studies discussed above.

b) Generation Interconnection Agreement and the Notification of New or Modified Facilities

The GIA between MISO, DPC, and the generation project developer will identify, if applicable, new transmission facilities or modified existing transmission facilities required for this interconnection of the generating unit. DPC and/or the generation project developer shall submit the data related to these new or modified facilities to the MISO model building process and the MISO Transmission Expansion Plan (MTEP) process. The MISO MTEP process is designed to be fully compliant with FERC Orders 890 and 890-A. Since the MISO MTEP process is an open and transparent planning process, the notification of neighboring utilities and neighboring balancing authorities of these new or upgraded transmission facilities is accomplished through the MTEP planning process. The "MISO Business Practices Manual Transmission Planning BPM-020" defines how to submit this data into the MTEP process.

III) DPC INTERCONNECTION PROCESS FOR TRANSMISSION BELOW 69 kV

Instances where a generation project developer intending to interconnect generation with the DPC Transmission System outside of the MISO interconnection process is governed by the DPC process which closely follows the MISO Tariff process described herein. **This**

[3] The GIA process may also include a Facilities Construction Agreement if applicable.

process should not be used for 69 kV and above interconnection requests. Instead use the MISO interconnection process.

DPC will work with the generation project developer throughout the GIP study process. The DPC GIP and study process overview is as follows:

a) Application, Application Review and Study Deposit

i) Application

The first step for the generation developer is to fill out a DPC generation interconnection application. The DPC generation interconnection application is found at the end of this document.

ii) Study Deposit

DPC requires a $10,000 down payment to cover the system impact study and the facility study. This down payment along with the interconnection application should be sent to DPC at the following address:

Supervisor, Transmission Planning
Dairyland Power Cooperative
3200 East Avenue South
La Crosse, WI 54601

iii) Application Review

DPC will review the generator interconnection request and either clarify information on the request or deem the request complete. Once the request is deemed complete and a study deposit is received, the study process can begin.

iv) Study Process

The first step in the study process is the execution of the System Impact Study and Facility Study Agreement. The System Impact Study may include a power flow analysis study, a fault study, and a stability study to determine the impacts on the DPC Transmission System. The Facility Study determines the project feasibility, and provides an engineering cost estimate (+/- 20%) of the infrastructure upgrades needed for the project. If the generation developer decides to proceed with the project the next step is to execute a Facilities Construction Agreement for the needed upgrades. If the generation developer does not execute the Facilities Construction Agreement within 18 months the project is removed from the DPC queue and the application is considered terminated.

v) Generator Interconnection Agreement

The final step in the execution of the Generator Interconnection Agreement is the terms and conditions are finalized and documented.

IV) INTERCONNECTION TECHNICAL/ DESIGN REQUIREMENTS

The following requirements apply to all equipment operated in parallel with the DPC Transmission System. All generation interconnections must meet the applicable NERC and MRO standards along with the requirements of MISO acting as the Security Coordinator for the DPC Transmission System.

a) Substation

A generation project developer seeking interconnection may interconnect at an existing DPC station or via a tap into a DPC transmission line. The configuration requirements of the interconnection are dependent on where the physical interconnection is to occur and the performance of the DPC Transmission System with the proposed interconnection. DPC uses two standard substation configurations in various parts of its system; straight bus and ring bus. If the generation project developer interconnects in an existing DPC substation, the interconnection must conform to the designed configuration of the substation. DPC may consider different configurations if physical limitations exist at the site.

If the generation project developer interconnects via a tap into an existing DPC 100 kV and above transmission line, DPC requires establishing a breaker/ring bus substation configuration. Also, a breaker station is required at any voltage, if (note: DPC does not allow a ring bus configuration for 69 kV interconnections):

- Due to projected power flow levels, DPC cannot switch out its interconnecting line sections for maintenance without requiring an outage to the generator.
- Due to projected power flow levels, DPC cannot switch out its interconnecting line sections for maintenance without requiring the generation project developer to run its generation.
- If the multi-terminal line (three or more) created by the interconnection cannot be adequately protected for transmission line faults.

If the interconnection is at 69 kV, DPC may allow a radial tap connection. This is provided the system relay protection is adequate for both DPC's and the generation project developer's facilities with such a configuration.

i) Site

If the generation project developer is not interconnecting at an existing DPC substation, the generation project developer must provide a site. If the generation project developer is interconnecting at an existing DPC substation, the generation project developer must purchase enough land adjacent to the existing substation to accommodate the interconnection. This site must be capable of accommodating the DPC Interconnection Facilities to accomplish the interconnection.

ii) Generator Step-Up Transformer

The generator step-up transformer is usually connected such that it isolates the zero sequence circuit of the generator from the zero sequence circuit of the DPC Transmission System. The Facilities Study will determine the transformer connection and grounding configuration required.

iii) Disconnect/Interconnection Switch

A disconnect device must be installed to isolate the DPC Transmission System from the generator. This disconnect shall be installed and owned by the generation project developer and shall provide a visible air gap to establish required clearances for maintenance and repair work of the DPC Transmission System. DPC does not consider the integral switch available on some circuit-switchers as an acceptable way to meet this requirement. DPC may require the design to allow the application of personnel safety grounds on DPC's side of the disconnect device. OSHA lockout/tag safety requirements shall be followed.

The disconnecting device shall be accessible at all times to DPC personnel. The disconnects shall provide a feature such that the disconnects can be padlocked in the open position with a standard DPC padlock. The generation project developer shall not remove any padlocks or DPC safety tags. The generation project developer shall provide access to disconnects at all times (24-hour telephone number, guard desk, etc.). The disconnect equipment shall be clearly labeled. The disconnect equipment shall be approved by DPC for the specific application and location.

iv) Design Data

Design Temperature Range (°C)	-49° C to 40° C (-56° F to 104° F)
Wind Velocity (max. steady state)	80 mph
Design Ice Loading	One-half (1/2) in. radial
Frost Depth	4 - 5 feet

General Criteria

Codes and Standards	The substation and substation equipment shall meet applicable codes and standards, such as the National Electrical Safety Code (NESC), the National Electrical Code (NEC), RUS BULLETIN 1724E-300, American National Standards Institute (ANSI) and IEEE.
Substation Design Life	40 years
Maximum Fault Current (A)	Transmission Line Specific
Required Bus Ampacity	Transmission Line Specific
Bus Materials	Generally aluminum tube, current rating is based on 40°C ambient and a 50°C rise.
Electric Clearances and Spacing	Requirement is to meet DPC's safe working clearances.
Grounding Study is required and must be submitted for DPC review.	The substation grounding design shall meet the recommendations of IEEE 80 and the requirements of the RUS Bulletin 1724E-300. The substation fence shall be connected to the substation grid.
Shielding Study is required and must be submitted for DPC review.	See RUS Bulletin 1724E-300 for guidance.

Site Preparation

Access Roads Required	Yes
Min. Width	24 ft
Min. Turn Radius	50 ft

Drainage Pattern	Crown slope of 0.02 ft per ft of road with and max of 3inches at road crown
Max. Slope	Preferred grade 5% maximum 7%
Surfacing Material Depth and Size	See RUS Bulletin 1724E-300

Oil Containment

Preliminary Risk Assessment	Responsibility of generation project developer

Foundation Design

Concrete	
a) Min. Comp strength @ 28 days	4000 psi
b) Rebar, strength	60.0 ksi

v) Substation Fence

Chain link fence is the DPC standard. This type of fence is covered by the following standard and is considered a protective barrier for unattended facilities, a security barrier for the public and the first line of defense as a wildlife deterrent. DPC standard fence height is <u>8 feet high: 7 feet of fabric plus a minimum of 1 foot vertical height of barbed wire</u>, mounted at a 45 degree angle, mounted outward from the substation.

vi) AC Station Service

Typically, substation AC systems are used to supply power to loads such as transformer cooling, oil pumps and LTCs; circuit breaker auxiliaries and control circuits; outdoor equipment heaters, lighting and receptacles; and control house lighting, receptacles, heating, ventilating, air conditioning and battery chargers.

Power supply shall be either a single-phase, 120/240 VAC, three-wire or a three-phase 120/240 VAC four-wire system for lighting, heating, maintenance and other site specific electrical needs. In order to standardize on equipment, DPC does **not** install 120/208 VAC auxiliary systems. The AC service shall meet the requirements of the National Electrical Code.

In substations, it is normal to provide both a preferred and emergency station auxiliary with a manual or automatic transfer to the emergency on loss of the preferred. In some substations where the transmission connection is critical to restoration after a system blackout, an emergency diesel generator may be required in order to maintain certain station auxiliaries in an operable condition.

vii) DC Station Service

The DC system supplies power for the circuit breakers, motor operated switches, instrumentation, emergency lighting, communications, fire protection system, annunciators, protective relaying and fault recorders at substations.

A standard DC system consists of three major components; a battery, a charger, and a distribution system. Normally, the battery is float charged by the battery charger. That is, the battery charger supplies all the continuous DC load connected to the bus and powers the battery in order to maintain it in a full state of charge. Under normal conditions, the battery does not supply any load, but is held in the fully charged condition, ready to supply the DC loads for continuous operation or simultaneous tripping events if all AC sources to the battery charger are lost.

DPC requires that batteries be sized to handle the normal continuous DC load for 12 hours following the loss of all station AC and still have the capacity left to handle a worst case tripping scenario with secondary trips due to a breaker failure. The battery charger shall be sized to be able to recharge a fully discharged battery within 12 hours while supplying the normal continuous DC station load.

viii) Cable

Cables shall be jacketed and insulated with cross-linked polyethylene or ethylene propylene rubber type insulation. Conductors shall be suitable for wet locations, direct burial, insulated and sized all in accordance with the National Electrical Code (NEC).

ix) Lighting

Substation lighting shall meet the requirements of the National Electrical Safety Code (NESC). Controls for yard and control house lighting shall be accessible to DPC at all times. DPC standards for lighting are available upon request.

x) Safety Grounding

The generation project developer is responsible for appropriate safety grounding of its equipment. The grounding safety standards that the generation project developer shall comply with are the IEEE Standard 80 and RUS Bulletin 1724E-300. At the point of interconnection, the generation project developer shall be compatible with DPC's existing ground grid.

The generation project developer shall submit the grounding system study and design for DPC review and approval. DPC requires the bonding of the substation fence to the ground grid. DPC grounding standards are available upon request.

b) Modeling Information

The generation project developer shall annually forecast the firm MW and MVAR usage on each plant reserve station auxiliary system, for when the generator is off-line, on-line or starting/stopping, whichever is greater. The generation project developer shall annually provide generator reactive capability curves, generator MW capability, generator Mvar capability and exciter saturation curves.

All generator/exciter/governor, transmission line, and generator step-up transformer manufacturers data sheets shall be available for modeling in transient/voltage stability, short circuit, and relay setting calculation programs.
All generation to transmission interconnections shall provide MISO (see MISO's Attachment X for required information) and DPC with the generation model data (which includes logic block diagrams; transfer function representations; definitions for all parameters including gains, and time constants; equipment ratings and other limits; one-line diagrams with the voltage levels and point of interconnection) for the proposed generation interconnection and any associated power conversion equipment and controls, if appropriate IEEE standard models exist. If IEEE models do not exist, applicant shall provide suitable user model(s) and associated documentation for use with the Power Technologies, Inc., "PSS/E" simulation program to facilitate steady-state ("power flow"), dynamic, and transient stability simulation of the generation power equipment's behavior.

c) Power Factor

The generation project developer shall provide for its own generator reactive power needs. All generation project developers shall design their generation controls and facilities to operate within a power factor range of 0.95 lagging to 0.95 leading at all expected generator power levels, which includes 100% to 0% power output for inverter base units. The generation project developer is required to supply or absorb reactive power while operating within this power factor range.

All generators shall be able to automatically control the voltage level by adjusting the machine's power factor within a continuous range based on the calculated (or tested) generating capability curve. The voltage set point that the generator needs to maintain will be established by DPC and adjusted as necessary. The plant must be capable of full reactive output whenever the voltage at the points of interconnection is within the range of 0.95 to 1.05pu. The use of a static VAR compensator(s) or similar device to meet these reactive requirements is acceptable.

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 generator's excitation system(s) shall conform to the field voltage vs. time criteria as specified in American National Standards Institute Standard C50.13 This criteria will provide adequate field voltage during transient conditions. Non-synchronous generators shall be designed to meet a similar Voltage Response Rate.

d) Power Quality Requirements

i) Voltage

The generation project developer’s equipment shall not cause excessive voltage excursions. The project will provide voltage compensation to comply with FERC Order 827.

For steady state voltage requirements the generation project developer should expect normal operating voltage of +/- 5% from nominal and contingency operating voltage of +/- 10%. The plant should be capable of start-up whenever the voltage at the points of interconnection are within the +/- 10% of nominal range. If the auxiliary equipment within the plant cannot operate within the above range, the plant will need to provide regulation equipment to correct the voltage level excursions to this equipment.

For dynamic voltage requirements, the DPC Transmission System is designed to avoid experiencing dynamic voltage dips below 70% due to external faults or other disturbance initiators. Accordingly, dropout of contactors of controls associated with static or rotor circuits or any essential generator auxiliaries should not occur during dynamic power system voltage swings to levels as low as 70%. High voltage swings of up to 1.2 are also possible.

ii) Flicker

Generation project developers shall adhere to the IEEE Standard 1453 criteria in Section 4: (Requirements for flicker measurements and acceptable flicker levels) for acceptable voltage flicker on the DPC Transmission System. The generation project developer shall be responsible and liable for corrections if the generator is the cause of objectionable flicker levels.

iii) Harmonics

The generation project developer's equipment shall not introduce excessive distortion to the DPC Transmission System's voltage and current waveforms per the IEEE 519. The harmonic distortion measurements shall be made at the point of interconnection between the generator and the DPC Transmission System and be within the limits specified in the tables below. DPC advises that the generation project developer analyze its compliance with the IEEE 519 standard during the early stages of planning and design.

VOLTAGE DISTORTION LIMITS

Bus Voltage At PCC	Individual Voltage Distortion IHD %	Total Voltage Distortion THD %
Below 69 kV	3.0	5.0
69 kV to 138 kV	1.5	2.5
138 kV and above	1.0	1.5

From: IEEE 519 Table 11.1

CURRENT DISTORTION LIMITS FOR NON-LINEAR LOADS
AT THE POINT OF COMMON COUPLING (PCC)
FROM 120 TO 69,000 Volts

Maximum Harmonic Current Distribution in % of Fundamental
Harmonic Order (Odd Harmonics)

I(sc)/I(l)	<11	11<h<17	17<h<23	23<h<35	35<h	THD
20	4.0	2.0	1.5	0.6	0.3	5.0
20-50	7.0	3.5	2.5	1.0	0.5	8.0
50-100	10.0	4.5	4.0	1.5	0.7	12.0
100-1000	12.0	5.5	5.0	2.0	1.0	15.0
1000	15.0	7.0	6.0	2.5	1.4	20.0

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

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

From: IEEE 519 Table 10.3

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

Any reference to "load current" in IEEE 519, should be interpreted as referring to output current of the interconnecting facility, as measured at the point of interconnection. The IEEE 519 document is available through IEEE.

The generation project developer shall be responsible for the elimination of any objectionable interference (whether conducted, induced, or radiated) to communication systems, signaling circuits, relay mis operation, failure of power system devices, overloading of power system devices or equipment (protective relays, capacitor banks, metering, etc.) arising from non-fundamental current injections into the DPC collector system from the generation project developer's facilities. Any reasonably incurred expenses (by DPC or others) to facilitate or implement remedial actions shall be reimbursed by generation project developer.

Control systems for any energy conversion equipment(s) employed shall be designed to preclude excitation of subsynchronous modes of oscillation of existing turbine-generators, during either steady-state or dynamic conditions, including converter re-start attempts or repeated commutation failure. Similarly, excitation of existing or new power system resonances (whether sub- or super-synchronous) due to non-fundamental current injection shall be effectively prevented.

iv) Low Voltage Ride Through

All generators connected to the DPC Transmission System shall be capable of "riding through" disturbances that depress system voltages, as required by MISO's Appendix G. All generators shall communicate the low voltage as-built ride-through capability of the generator following the commercial operation date.

e) Frequency Requirements

The generator's operating frequency shall normally operate between 59.5 to 60.5 hertz per frequency capability curve, Attachment 1 in NERC standard PRC-024.

The generation project developer will operate its generator consistent with DPC guidelines and requirements concerning frequency control. Generators shall be equipped with governors that sense frequency, and:

- Governors shall provide a zero to ten percent (0-10%) adjustable setting nominally set at a five percent (5%) droop characteristic unless agreeable to DPC.

- Governors shall be maintained and tested in accordance with the manufacturer's specifications to maintain the performance stated in this section. The generation project developer shall, at its sole expense, be responsible for this maintenance and testing.

f) Fault Current

DPC's protective equipment fault current capability is based on exceeding the maximum fault current available at a location. If the installation of generating equipment causes these fault current limits to be exceeded, the generation project developer shall install equipment to limit the fault current on the DPC Transmission System or compensate DPC for the additional costs of installing equipment that will safely operate within the available fault current.

The generation project developer's equipment shall exceed the maximum fault current available. The exact value of available fault current depends upon location and circuit configuration and will be determined in the Facilities Study. The generation project developer shall work closely with DPC at the time of interconnection design to determine the available fault current at the specific location of interconnection.

g) Fault Detection and Clearing/Breaker Duty

The generation project developer shall provide and maintain in operable condition protective equipment to detect faults on its equipment and systems. At no time will the generation project developer operate its system without this protective equipment.

The generation project developer shall provide and maintain systems capable of interrupting maximum fault levels within the generator's step-up transformer, reserve station auxiliary transformer and generator outlet. Circuit breakers shall be capable of interrupting present and future available fault current at the location at which they are being installed. Fault currents may increase on the DPC Transmission System over time, the generation project developer shall periodically check fault levels to ensure its breaker meets these ever increasing values. It is presumed that the installation meets the NEC/NESC certified by appropriate authorities to ensure safety of DPC personnel.

Fusing of the generation project developer's step-up transformer is permitted for the reserve station auxiliary, station auxiliary, or the unit step-up transformer if interconnected with the 69 kV and smaller than 10 MVA. A high side circuit switcher or circuit breaker is required to clear faulted step-up transformers greater than 10 MVA.

The relay protection for the generation project developer's step-up transformer smaller than 10 MVA may trip the 69 kV transmission line, however, the generation project developer shall take appropriate precautions to minimize such events, such as avoiding high salt spray locations and providing station animal protection. The relays shall be compatible with and coordinate with existing DPC Transmission System protection equipment.

- Application of ground switches to trigger remote tripping is an unacceptable practice.
- The generation project developer's internal auxiliary equipment, generator, or generator step-up transformer must not trip the transmission line as a primary protection method.
- The generation project developer shall immediately and automatically isolate any faulted or failed equipment from the DPC Transmission System. This automatic equipment shall be compatible with the existing transmission protection equipment.

h) Basic Voltage Impulse Insulation Level

The generation project developer shall ensure that all equipment is adequately protected from excessive system over-voltages. This includes selection of equipment Basic Impulse Insulation Level (BIL) and protective devices (e.g., surge arresters) to achieve proper insulation coordination and Surge Protections. The addition of new transmission facilities to the DPC Transmission System in general shall be modeled, and Transient Network Analysis (TNA) or Electromagnetic Transients Program (EMTP) studies may be required. If such studies are needed, then they shall be completed before other major engineering work on the project commences. The following table indicates voltage and BIL levels found on most of the DPC Transmission System

NOMINAL SYSTEM VOLTAGE	MAXIMUM NORMAL SYSTEM VOLTAGE	BASIC IMPULSE LEVELS (BIL)*
13.8	14.4	110
23	24.1	150
34.5	36.2	200
69	72.5	350
115	121	550
161	169	750

* Expressed in **kV** crest value of withstand voltage.

i) Arresters

In general, all DPC incoming lines shall be protected with surge arresters located on the line side of disconnect switch. DPC specifications for surge arresters are available upon request.

j) Energization of DPC Equipment by the Generation Project Developer

The generation project developer shall not energize a de-energized DPC circuit. The necessary control devices shall be installed by the generation project developer on the equipment to prevent the energization of a de-energized DPC circuit by the generator. Connection may be accomplished only by synchronization with the DPC Transmission System via synchronizing relays installed by the generation project developer.

k) Synchronization of Generator

The generation project developer is responsible for synchronization of its generation to the DPC Transmission System. Synchronization relays are required for the protection of the generation project developer's and DPC's equipment. DPC is not responsible for the appropriateness of the generation project developer's synchronization relaying. It is highly recommended that the generation project developer consult with the equipment suppliers or manufacturers for the settings that are appropriate for the protection of the generation project developer's and DPC's equipment.

DPC requires synchro check relays on all circuit breakers directly interconnecting to the DPC Transmission System. DPC will establish the setting it requires for protection of its system for these relays.

l) Automatic Line Reclosing

The generation project developer will coordinate with DPC's Electrical Engineering Department to ensure appropriate reclosing operation following a transmission line trip. Reclosing will be coordinated with all automatic sectionalizing devices and remote end circuit breaker reclosing.

m) System Restoration/Black Start Capability

Under an extreme emergency, large portions of the U.S. electric power grid may shut down. A regional power system restoration plan has been developed by MISO members to ensure that the system can be restarted and returned to normal operation as soon as possible following a system-wide black-out. The process involves the use of power generation facilities with the following characteristics:

1. Ability to start without any utility supplied energy requirements
2. Ability to attain and regulate itself at a synchronous speed
3. Ability of self-excitation to build-up generator field and subsequent stator voltages

4. Ability to energize a dead bus, line, transformer
5. Ability to absorb significant amounts of VARs due to unloaded transmission line charging, with capacity remaining to provide cranking power to non-black start generation facilities

n) Safe Working Clearances

These safe working requirements are for all personnel working in proximity to DPC's Transmission System.

System Voltages		Switch Spacings Measured Center-to-Center						Clearances	
Nominal	Impulse Withstand	Vertical Break Disconnect Switches and Non-Vented Fuse Units		Side Break Disconnect Switches (Center, Single-End and Double-End)		Vertical and Side Break Horn-Gap Switches and Vented Fuse Units		External Live Parts of Power Transformers **(2)**	
(Ph-Ph) (kV)	(BIL) (kV)	Minimum † (ft-in) **(1)**	DPC □ (ft-in)	Minimum † (ft-in) **(1)**	DPC □ (ft-in)	Minimum †† (ft-in)	DPC □ (ft-in)	(Ph-Grd) (ft-in)	(Ph-Ph) (ft-in)
2.4-7.2	95	1-6	3-0	2-6	3-0	3-0	4-0	0-4½	0-5
13.8	110	2-0	3-0	2-6	3-0	3-0	4-0	0-6	0-6½
23	150	2-6	3-0	3-0	4-0	4-0	5-0	0-8	0-9
34.5	200	3-0	3-0	4-0	4-0	4-0.	6-0	1-0	1-1
69	330	5-0	7-0	6-0	7-0	7-0	8-0	1-11	2-1
115	550	7-0	9-0	9-0	9-0	9-0	10-0	3-1	3-5
161	750	9-0	9-0	13-0	13-0	13-0	14-0	4-4	4-9

( ) Indicates an application note below.

□ DPC Recommended Switch Spacings are DPC adopted values that are always greater than or equal to Minimum values taken from accepted national code publications.

† Minimum values taken from NEMA Standards Publication No. SG6-1974 (R1979), Appendix A, Table 1 "Outdoor Substations -Basic Parameters," under column heading "Recommended Phase Spacing Center to Center for ...Vertical Break Disconnect Switches and Non-Expulsion Type Power Fuses..."

†† Minimum values taken from NEMA Standards Publication No. SG6-1974 (R1979), Appendix A, Table 1 "Outdoor Substations -Basic Parameters," under column heading "Recommended Phase Spacing Center to Center for Horn Gap Switches and Expulsion Type Fuses."

1. The Minimum values for vertical and side break switches may be reduced dependent upon the switch manufacturer. However, in no case should the surface-to-surface distance between energized parts be less than that shown in Standard ED 4.02.02.01.

2. The surface-to-surface clearance values used for external live parts of power transformers are based on NEMA Standards Publication TR1-0.15.

o) Automatic Generator Control

To comply with NERC Control Performance Criteria, the generator shall be equipped with Automatic Generator Control equipment to permit remote control and enable the generation to be increased or decreased via Automatic Generation Control (AGC). This requirement does not apply if the plant is exempt under MISO and NERC rules due to prime mover or regulatory limitations.

p) Power System Stabilizers

To comply with MRO reliability requirements, generators 75 MVA and larger must be equipped with Power System Stabilizers (PSS) to damp power oscillations, unless an exemption to this requirement is approved by MRO. The PSS is to be tuned to the electric transmission system mode of oscillation.

q) Supervisory Control and Data Acquisition (SCADA) for Generation Facilities

All substations with a 69 kV or greater voltage circuit breakers must provide remote operation of the circuit breaker to a 24-hour staffed entity that has NERC-certified operators. In addition, the following equipment data and statuses must be provided in an 8 second or less periodicity to the 24-hour entity:

- 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
- Cap/Reactor status
- Other points as necessary to provide comparable control and indication to the DPC control standard

V) PROTECTIVE DEVICES

Protective devices are required for safe and proper operation of the generator interconnection. DPC shall operate all DPC-owned protective equipment at the interconnection to ensure that these requirements are met. During interconnection studies, DPC will approve the proposed type of interconnection protective devices, ownership, operating details and equipment settings**.** Do not confuse interconnection protection in this section with generation project developer system protection. DPC is not liable or responsible for the generation project developer’s system protection.

Protective devices, such as protective relays, circuit breakers, circuit switchers, etc., shall be installed by the generation project developer to disconnect the generator from the DPC System whenever a fault or electrical abnormality occurs. Such equipment shall coordinate with existing DPC equipment and provide comparable levels of protection as practiced on the DPC Transmission System. Major factors generally determining the type of protective devices required include:

1. The type, ratings and size of the generation project developer's equipment
2. The location of the generator on the DPC Transmission System
3. The manner in which the installation will operate (one-way vs. two-way power flow)

Protective relays are required to promptly sense abnormal operating or fault conditions and initiate the isolation of the faulted area. DPC requires that the generation project developer use DPC-approved relays to coordinate with the new or existing protective relays. The specific requirements will be determined in the Facilities Studies.

a) Protective Relays and Coordination

Protective relays will sense abnormal operating or fault conditions and initiate the isolation of the faulted area. The generation project developer shall install only DPC approved relays where they may impact the operation of the DPC Transmission System. These relays shall meet a minimum of IEEE standards C37.90, C37.90.1, C37.90.2 and C37.90.3.

The generation project developer shall submit complete control and relaying documentation for DPC review and coordination. DPC will approve only those portions of the document that pertains to the protection of the DPC Transmission System. DPC may make suggestions or comment on other areas, however, the generation project developer is responsible for the design of protection schemes protecting the generation project developer's facilities.

b) Relay Protection Function Requirements

The following protective relay recommendations are necessary for DPC to supply its members and customers with a stable, intact electrical system when third-party generation is supplying power to DPC members and customers through an interconnection or in an islanding situation.

1. Minimum Requirements

These functions will protect DPC's equipment and its member's and customers' equipment against electrical faults (short circuits), degraded voltage operation, abnormal frequency operation, abnormal power flows and inadvertent out of phase closing of breaker/switches. The following is a list of the minimum relays required:

- Over/Under Frequency (81O/U)
- Over/Under Voltage (27/59)
- Over Current (51, 51V) - for faults and over load
- Ground Over Voltage (59 G) - ground fault protection for ungrounded system at the generation project developer's end
- Reverse Power (32) toward the DPC Transmission System when the generation project developer is not selling power to DPC
- Synchronizing (25)

2. Other Requirements (Determined in MISO's Facilities Study)

   Additional protection functions may be suggested or required depending upon the size of the generator, nature of interconnection and coordination requirements with DPC Protective Systems. The generation project developer's relay system shall match the DPC relay system when interconnected at the transmission voltage. The exact relay protection requirements shall be determined during the Facilities Study. Below is a list of the other relays that maybe required:

   - Impedance (21) - Where over current functions may not be adequate
   - Out of Step (68) - During system disturbance, the tie may have to be separated.
   - Breaker Failure (50BF)
   - Bus Differential (87)
   - Transfer Trip (TT)
   - Directional Overcurrent (67)

c) Communication Channels for Protection

DPC 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 generator from the DPC Transmission System due to a fault or other abnormal conditions which cannot be sensed by the protective devices at the generation project developer's location. Some instances may require installation of communication equipment in DPC substations to initiate the protective signals.

DPC will design, acquire and commission communications equipment for protection. Details of the requirements will be documented in the Facilities Study. DPC shall be reimbursed by the generation project developer for the cost of this equipment, installation and monthly maintenance fees.

d) Back-Up Relays

The failure to trip during 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. For this reason, DPC requires redundant and back-up relay protection.

VI) METERING AND TELEMETRY

All generating units and transmission facilities (needed for the generator interconnection) are required to provide metering such that the delivery of power and energy to or from the generation project developer's interconnection can be determined. The metering/recording devices shall be capable of remote communication. This remote interrogation will require the installation of a communication line. DPC prefers using fiber optics as a mean of communications but other communications media may be used such as an existing telephone line, microwave circuit, etc. The communication requirements and metering will be stated in the Facilities Study.

When DPC is purchasing the generation project developer's power or providing ancillary services, DPC will own and maintain the metering, telemetry, and communications equipment.

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 shall adhere to the "Accuracy Classifications for Metering" listed in ANSI standard C-57.13.

DPC requires 3 element metering. The impedance of the PT and CT secondary circuits shall be within the meter class accuracy ratings of the devices. Metering CTs shall be connected exclusively to metering devices.

b) Metering 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. DPC'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-DPC generation sites is tested annually.

The periodic test frequency for the metering equipment will be decided upon during the interconnection studies. DPC, at its option, may participate in the periodic testing. The party performing the testing must notify the witnessing party four weeks prior to the proposed test date. If the proposed date is not acceptable, then an alternative time acceptable to both parties, must be worked out.

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

c) Metering and Telemetry Function Requirements

The meter and telemetry requirements define DPC'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.]. The metering installations between DPC and the generation project developer shall be electrically connected at the point of interconnection (POI).

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

1. The type, rating and size of the generator equipment
2. The location of the generator on the DPC Transmission System
3. The manner in which the installation will operate (one-way vs. two-way power flow)

Each request will be handled individually, and DPC will solely determine the metering and telemetry modifications and/or additions required. DPC will work with the generation project developer to achieve an installation which meets the requirements of both the generation project developer and DPC. The generation project developer shall bear the costs of metering and telemetry modifications required to permit the operation of parallel generation.

d) Energy Losses

If the energy is not metered at the POI where the energy exchange between DPC and the generator has been defined by contract, energy losses must be determined. Accounting for the losses may be done either by attributing losses to the monthly accounting of exchanged energy or by attributing losses directly to the energy registered on the meter. A compensated billing meter shall be required for losses directly registered on the meter. Losses applied directly to the meter frequently result in a more complex metering and telemetering situation. Therefore, compensated billing metering should be thoroughly evaluated before this approach is used.

e) 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 shall be completed as soon as possible after it has been detected. If the metering cannot be repaired as soon as possible, DPC may request the generation project developer cease all generation until the meter has been repaired.

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

f) Communications Channels for Monitoring/ Control

Telemetry is required if the generation project developer has a generator (or generating station or farm) greater than 0.1 MW in total capability, provides their own ancillary services, or is on a black start transmission path. Telemetry is required for these interconnections regardless of equipment ownership. It is also required for real time visibility of the DPC EMS system and state estimator model. The equipment shall additionally be able to communicate with the DPC EMS at a minimum of every 24 seconds.

These dedicated communication channels are needed for monitoring and control purposes. The Facilities Study shall determine the specific communication channel requirements. DPC will design, acquire and commission communications equipment for monitoring and control. Details of these requirements will be documented in the Facilities Study. DPC shall be reimbursed by the generation project developer for the cost of this equipment, installation and monthly maintenance fees.

VII) PRE-PARALLEL REQUIREMENTS AND INSPECTION

Prior to the actual operation of generator with the DPC Transmission System, all pertinent contracts shall be signed, and all new equipment installations and modifications shall be complete. In addition, the generation project developer shall have the interconnection installation inspected and certified by a qualified technician 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 Facilities Study.
- 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.

A more detailed list of required inspections is provided in Appendix A. DPC may waive or add additional test requirements based on the specific conditions of the proposed interconnection.

DPC may, at its option, witness the inspection. The generation project developer must give DPC at least a two week notice of upcoming tests and provide their test procedures for DPC approval prior to the tests. The certification and test report will be furnished to both the generation project developer and DPC as soon as practical.

Upon performance and certification of the pre-parallel inspection, the generation project developer shall be granted approval for operation of the generating equipment in parallel with the DPC Transmission System. Neither the inspection nor the granting of approval to the generation project developer shall serve to relieve the generation project developer of any liability for injury, death or damage attributable to the negligence of the generation project developer. The inspection and approval does not constitute a warranty or relieve the generation project developer of responsibility for the operating condition or installation of the equipment and may not be relied upon by the generation project developer for that purpose. If the operation of the interconnection facilities are suspected of causing problems on other DPC Transmission System, then DPC shall retain the right to inspect at its discretion.

Once the facility is interconnected, DPC shall retain the right to inspect the existing facilities. This is especially true for modifications or design changes to the interconnection. These new or existing facilities and protective devices owned by the generation project developer shall be maintained and inspected according to manufacturer recommendations, industry standards and NERC reliability standards. Procedures shall be established for visual and operational inspections; in addition, provisions shall be established for equipment maintenance and testing. Equipment shall include, but not be limited to:

- Current Transformers
- Potential Transformers
- Circuit Breakers
- Protective Relays
- Control Batteries

- Communications
- DC Circuitry

DPC maintains the right to review maintenance, calibration and operation data of all protective equipment for the purpose of protecting DPC facilities and other DPC members and customers. The generation project developer is responsible for providing the necessary test accessories (such as relay test plugs, instruction manuals, wiring diagrams, etc.) required to allow DPC to test these protective devices. Verification may include the tripping of the interconnection tie breaker.

If DPC performs work on the generation project developer's premises, an inspection of the work area may be made by DPC operating personnel. If hazardous working conditions are detected, the generator owner shall be required to correct the unsafe conditions before DPC will perform the work.

VIII) OPERATING GUIDELINES

The generation project developer shall operate the generating equipment within the guidelines of this document and any special requirements set forth by established agreements.

a) Normal Conditions and Communications

The generator is operating to the instructions and approval given by MISO and the DPC System Operations Center personnel:

- The generation project developer shall notify DPC System Operations personnel of all generator stops, starts, de-rates, and outages.
- All generators operating in manual and automatic mode when requested.
- The generation project developer has twenty-four hour support available.

With interconnected generation, generation project developer equipment events or actions may impact the DPC Transmission System and DPC system events may impact the generator. Consequently, communication between parties is very important. A DPC representative shall provide the generation project developer with the names and phone numbers of the DPC System Operations Center personnel who are responsible for the DPC Transmission System at the interconnection. The generation project developer shall provide DPC with the names and phone numbers of the generation project developer's contact(s) with responsibility for operating the generator.

Generation project developer contact(s) shall include at least one 24-hr phone number. Contacts shall be able to provide information on equipment status, explanation of events on generation project developer's equipment, and relay target and alarm information when asked to do so by DPC System Operations Center personnel. Also, the generation project developer shall contact DPC whenever:

- Problems with the generator or substation equipment are detected that could result in mis operation of the relay protection or other generator/substation equipment.
- The generator has tripped off line during Parallel Operation with the DPC Transmission System.
- Generator or substation equipment problems result in an outage to a portion of the DPC Transmission System.
- The generation project developer intends to initiate switching to parallel the generator(s) or energize the substation with the DPC Transmission System.
- The generation project developer intends to open the parallel interconnection between its system and the DPC Transmission System.

DPC may choose to waive some of the communications requirements for smaller generating facilities.

b) Abnormal Conditions

DPC reserves the right to open the interconnection tie circuit breaker or disconnect device for any of the following reasons:

- DPC performing line maintenance work on the DPC Transmission System.
- DPC Transmission System emergency.
- Inspection of generation project developer's equipment and protective devices reveals a hazardous condition.
- Failure of the generation project developer to provide maintenance and testing reports when required.
- The generation project developer's equipment interferes with other DPC members or customers or with the operation of the DPC Transmission System.

- The generation project developer has modified the generating equipment or protective devices without the knowledge or approval of DPC.

- Parallel Operation of any unapproved equipment.

- Personnel and public safety is threatened.

- Failure of the generation project developer to comply with applicable OSHA Safety Tagging and Lockout requirements.

- To address abnormal frequency, voltage conditions or power quality conditions that are adversely impacting the DPC Transmission System.

The failure of DPC to open the interconnection tie circuit breaker or disconnect device shall not serve to relieve the generation project developer of any liability for injury, death or damage attributable to the negligence of the generation project developer.

Changes to the DPC Transmission System, or the addition of other generation project developers with generation in the vicinity, may require modifications to the interconnection protective devices. If such changes are required, the generation project developer may be subject to future charges for these modifications.

c) Maintenance Notification/Coordination

The generation project developer is required to notify and coordinate with DPC and MISO for any of the following reasons:

- Partial operating capability due equipment limitations and fuel shortages.

- Normal equipment maintenance.

- Scheduled outage periods and return to service expectations. Return to service notification must be updated daily to reflect the recent progress or the lack of progress.

d) Operating Data Submittals

The generation project developer is required to provide operating data and equipment modeling to DPC to support the following:

- NERC compliance program(s).

- MRO compliance program(s).
- Federal, state, and local regulatory programs.

IX) GLOSSARY

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

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

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

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

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

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

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

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

Cogeneration: The concurrent production of electricity and heat, steam or useful work from the same fuel source.

Current: A flow of electric charge measured in amperes.

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

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

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

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

Energy Losses: The general term applied to energy lost in the operation of an electrical system. Losses can be classified as Transformation Losses, Transmission Line Losses or System Losses.

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

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

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

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

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

Incoming Breaker: The generation project developer owned breaker which connects DPC source of power to the generation project developer's bus.

Interconnection: The physical system of electrical transmission between the generation project developer and the utility.

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

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

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

Kilovolt (kV): One thousand volts.

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

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

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

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

Local Balancing Area: A Load Balancing Area is an electrical system bound by interconnect (tie- line) metering and telemetry. It contributes to frequency regulation of the Interconnection and fulfills its obligations and responsibilities in accordance with NERC and reliability region requirements.

MISO Tariff: the tariff through which MISO provides open access transmission service and Interconnection Service are offered, as filed with the FERC, and as amended or supplemented from time to time.

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

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

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

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

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

Point of Interconnection: The point where the Generation project developer's conductors meet DPC's (point of ownership change).

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

Power Flow: <u>One-way power flow</u> is the condition where the flow of power is entirely into the generation project developer's facility.
<u>Two way power flow</u> is the condition where the net flow of power may be either into or out of the generation project developer's facility depending on the operation of the generator and other customer load.

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

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

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

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

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

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

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

Voltage: Electric potential or potential difference expressed in volts.

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

VAR: Volt ampere reactive, see Reactive Power.

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

X) REFERENCES

"National Electrical Safety Code," ANSI C2-1993, Published by The Institute of Electrical and Electronics Engineers, Inc.

"IEEE Standard Relays and Relay Systems Associated with Electric Power Apparatus," ANSI/IEEE C37.90.

"Guide for Protective Relaying of Utility - Consumer Interconnections," ANSI/IEEE C37.95.

"IEEE Guide for Interfacing Dispersed Storage and Generation Facilities with Electric Utility Systems," IEEE Std. 1001.

IEEE Recommended Practice for Utility Interconnection of Small Wind Energy Conversion Systems," ANSI/IEEE Std. 1021.

"Intertie Protection of Consumer-Owned Sources of Generation, 3 MVA or Less," IEEE Publication 88 THO224-6-PWR.

"Reliability Considerations for Integrating Non-Utility Generating Facilities with the Bulk Electric Systems," North American Electric Reliability Council, Princeton, NJ 8540, April 1987.

Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - "Buff Book:," ANSI/IEEE Std. 242.

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

National Electrical Code, NFPA-70-2008, National Fire Protection Association, Quincy, MA 02269 Edition.

"IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems," IEEE Standard 519.

OSHA Safety Tagging and Lock-out Procedures.

Network Transformer Protection Guide, ANSI C37, 108.

"IEEE Guide for safety in AC Substations grounding," IEEE 80 published by the Institute of Electrical and Electronic Engineers, Inc.

NERC Reliability Standard FAC-001, Facility Connection Requirements.

Appendix A

PRE-PARALLELEL ACCEPTANCE TESTING STANDARDS

<u>POWER TRANSFORMERS</u>

Physical Testing

- A. Power Factor Test (Doble) Winding, Bushing & Arresters
  1. Measure Transformer Turns Ratio (TTR)
  2. Measure Winding Resistance
  3. Ratio Test Current Transformers

Control Testing

- A. Local tests done at the transformer
  1. Function heater circuit
  2. Check calibration of temperature gauges
  3. Local function test of fan and pump controls
  4. Local function test LTC control
- B. Wire check AC circuits
- C. Calibrate relaying
- D. Calibrate metering
- E. Function test control circuits (operate lockouts, sudden pressure, etc.)
- F. Perform system test of LTC control including paralleling with other transformer(s)
- G. Check controls to control house including Tap Position Indicator (TPI)
- H. Test and document EMS control, alarms and status

<u>CIRCUIT BREAKER/RECLOSER TESTS</u>

Physical Testing

- A. Record Nameplate Data
- B. Operational Check of Mechanism
- C. Timing & Velocity Tests
- D. Doble Power Factor Test
- E. Measure Contact Resistance

Control Testing

- A. Ratio Test CTs
- B. Local checks at the breaker
  1. Function test heater circuit. (check wattage)
  2. Function test control circuits (trip, close, block trip/close, dual trip coil, anti-pump, etc.)
  3. Check labeling of fuses, switches and relays
  4. Check calibration of relays at breaker except low gas
- D. Set and test protective relays
- E. Verify metering calibration

F. Function test control circuits from control house
G. Test and document EMS analog, control, alarms and status

MOTOR OPERATED DISCONNECTS

Control Testing

A. MOD tests

1. Function heater circuit.
2. Function of controls from control house.
3. Test and document EMS control and status

REGULATORS – Single phase

Control Testing

A. Function controls

1. Test for proper voltage control once regulator is placed in-service

CAPACITOR BANK

Physical Testing

A. Measure and record capacitance of individual capacitors with capacitance meter.

Control Testing

A. Function control circuits
B. Test and document EMS analog, control, alarms and status

TRANSMISSION LINE

Control Testing

A. Wire check AC circuits
B. Check Line PTs
C. Set and test protective relays
D. Set up pilot relaying and transfer trip equipment common to all piloted systems
1. Apply settings
2. Perform “back to back” local function tests when possible
3. Perform “end to end” piloted relaying and transfer trip tests
4. Record installed signal receive levels
5. Check alarms to annunciator and EMS
E. Test meters
F. Function all relaying control and protection circuits, then document results
G. Perform tuning of carrier equipment on ungrounded line
H. Perform “end to end” tests for piloted relaying
I. Perform “end to end” tests for transfer trip

RTU AND ANNUNCIATOR TESTS

A. RTU tests
B. Traditional Annunciator testing

Pre-check all points including spares

Verify labeling matches print

SUBSTATION BATTERIES & CHARGERS

Physical Testing

A. Substation batteries and charger

1. Clean, lubricate and install inter-cell connectors.
2. Torque inter-cell connectors
3. Measure and record resistance of Inter-cell connectors, Cell Voltage, Cell Impedance, and Hydrometer readings.

Control Testing

A. Test and document EMS alarms

DAIRYLAND POWER COOPERATIVE

Generation Application for Distribution Interconnections

This application is used by DPC to perform an Interconnection Study for interconnection requests with the point of interconnection below 69 kV only. Every effort should be made to supply as much information as possible.

ADDITIONAL REQUIREMENTS: In addition to the items listed on this form, please attach: 1) a detailed one-line diagram of the proposed facility, 2) site plan, relaying, metering telemetry and any other applicable diagrams, and 3) major equipment (generators, transformers, inverters, circuit breakers, protective relays, isolation disconnect, etc.) specifications, test reports and other applicable drawings or documents necessary for the proper design of the interconnection.

OWNER/APPLICANT INFORMATION		
Company:		
Representative:	Phone Number:	FAX Number:
Title:		
Mailing Address:		
LOCATION OF PROPOSED INTERCONNECTION		
Address:		
TYPE OF PROPOSED INTERCONNECTION (Transmission Tap, Breaker Bay Addition, Generation, etc…)		
PROJECT DESIGN / ENGINEERING		
Company:		
Representative:	Phone:	FAX Number:
Mailing Address:		
ELECTRICAL CONTRACTOR		
Company:		
Representative:	Phone:	FAX Number:
Mailing Address		

ESTIMATED LOAD INFORMATION			
The following information will be used to help properly design the DPC-Customer interconnection. This information is not intended as a commitment or contract for billing purposes.			
Minimum anticipated load (generation not operating):		kVA:	Time:
Maximum anticipated load (generation not operating):		kVA:	Time:
SYNCHRONOUS GENERATOR DATA (If applicable)			

Unit Number:	Total number of units with listed specifications on site:		
Manufacturer:			
Type:	Date of manufacture:		
Serial Number (each)			
Phases: 1 or 3	Speed (RPM):	Frequency (Hz):	
Rated Output (each unit) Kilowatt:	Kilovolt-Ampere:		
Rated Power Factor (%):	Rated Voltage(Volts):	Rated Current (Amperes):	
Field Voltage (Volts):	Field Current (Amperes):	Motoring Power (kW):	
Synchronous Reactance (X_d):	% on	kVA base	
Transient Reactance (X'_d):	% on	kVA base	
Subtransient Reactance (X''_d):	% on	kVA base	
Negative Sequence Reactance (X_s):	% on	kVA base	
Zero Sequence Reactance (X_o):	% on	kVA base	
Neutral Grounding Resistor (if applicable):			
I^2t or K (heating time constant):			
Exciter data:			
Governor data:			
Note: Power System Stabilizer (supplemental excitation system) required on machines 75MW and larger.			
Additional Information:			

INDUCTION GENERATOR DATA (If applicable)

Rotor Resistance (R_r):	Ohms	Stator Resistance (R_s):	Ohms
Rotor Reactance (X_r):	Ohms	Stator Reactance (X_s):	Ohms
Magnetizing Reactance (X_m):	Ohms	Short Circuit Reactance (X_d''):	Ohms
Design Letter:		Frame Size:	
Exciting Current:		Temp Rise (deg C°):	
Rated Output (kW):			
Reactive Power Required:	kVARs (no Load)	kVARs (full load)	
If this is a wound-rotor machine, describe any external equipment to be connected (resistor, rheostat, power converter, etc.) to rotor circuit, and circuit configuration. Describe ability, if any, to adjust generator reactive output to provide power system voltage regulation.			
Additional Information:			

PRIME MOVER (Complete all applicable items)

Unit Number:	Type:		
Manufacturer:			
Serial Number:		Date of Manufacture:	
H.P. Rated:	H.P. Max:	Inertia Constant:	lb.-ft.^{2}
Energy Source (hydro, steam, wind, etc.):			

TRANSFORMER (If applicable)

Manufacturer:	kVA:

Date of Manufacture:	Serial Number:	
High Voltage: kV	Connection: ☐delta ☐ wye	Neutral solidly grounded?
Low Voltage: kV	Connection: ☐delta ☐ wye	Neutral solidly grounded?
Transformer Impedance (Z):	% on	kVA base
Transformer Resistance (R):	% on	kVA base
Transformer Reactance (X):	% on	kVA base
Neutral Grounding Resistor (if applicable)		

INVERTER DATA (If applicable)

Manufacturer: Model:	
Rated Power Factor (%): Rated Voltage (Volts): Rated Current (Amperes):	
Inverter Type (ferroresonant, step, pulse-width modulation, etc.):	
Type of Commutation: ☐ forced ☐ line	Minimum Short Circuit Ratio required:
Minimum voltage for successful commutation:	
Current Harmonic Distortion	Maximum Individual Harmonic (%): Maximum Total Harmonic Distortion (%):
Voltage Harmonic Distortion	Maximum Individual Harmonic (%): Maximum Total Harmonic Distortion (%):
Describe capability, if any, to adjust reactive output to provide voltage regulation:	

NOTE: *Attach all available calculations, test reports, and oscillographic prints showing inverter output voltage and current waveforms.*

POWER CIRCUIT BREAKER (if applicable)

Manufacturer:	Model:
Rated Voltage (kilovolts):	Rated Ampacity (Amperes):
Interrupting Rating (Amperes):	BIL Rating:
Interrupting Medium (vacuum, oil, gas, etc.)	Insulating Medium (vacuum, oil, gas, etc.)
Control Voltage (Closing): (Volts) ☐ AC ☐ DC	
Control Voltage (Tripping): (Volts) ☐ AC ☐ DC ☐ Battery ☐ Charged Capacitor	
Close Energy: ☐ Spring ☐ Motor ☐ Hydraulic ☐ Pneumatic ☐ Other	
Trip Energy: ☐ Spring ☐ Motor ☐ Hydraulic ☐ Pneumatic ☐ Other	
Bushing Current Transformers (Max. ratio):	Relay Accuracy Class:
Multi Ratio? ☐ No ☐ Yes: (Available taps):	

Construction Schedule:	Start date:	Completion date:

MISCELLANEOUS (Use this area and any additional sheets for applicable notes and comments)

Document Review

FAC-001 --- Generation Interconnection Guidelines

Last Review Date: 4-2-2020
Standard Owner: Terry Torgerson

Reason for Revision	Prepared / Reviewed/ Revised by	Secondary Review	Date
New Document	Terry Torgerson		9/2011
Annual Review	Terry Torgerson	Jerry Iverson	12/2012
Name change for MISO	Terry Torgerson	Jerry Iverson	7/2013
Added distribution interconnection and annual review	Terry Torgerson	Jerry Iverson	11/19/2013
Annual review	Terry Torgerson	Jerry Iverson	12/12/2014
Added materially modified existing interconnections	Terry Torgerson	Jerry Iverson	6/10/15
Updated MISO changes	Terry Torgerson	Jerry Iverson	7/25/17
Updated MISO links	Terry Torgerson	Jerry Iverson	4/2/2018
Updated frequency requirements per PRC-024, NERC reliability guideline, add BA information and removed hyper-links.	Terry Torgerson	N/A	12/2019
Minor changes	Terry Torgerson	Steve Porter	4/2/2020