Transmission to Distribution/ End-User Interconnection Guidelines for the Dairyland Power Cooperative Transmission System (new or materially modified existing interconnections)

Dairyland Power Cooperative
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Transmission to Distribution/ End-User (T-D) Interconnection Guidelines

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DAIRYLAND POWER COOPERATIVE

TRANSMISSION TO DISTRIBUTION INTERCONNECTION GUIDELINES
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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 distribution facilities that interconnect to and operate in parallel with the DPC Transmission System.

a) Purpose

By working with distribution project developers and neighboring load serving entities, DPC has developed long-term, successful distribution interconnections. This distribution interconnection guide describes the minimum requirements for connection to the DPC Transmission System.

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

[1] The DPC Transmission System does include a limited quantity of 34.5 kV, 115 kV, and 345 kV transmission assets that are subject to this Transmission Interconnection Guide document.

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.

iii) 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 distribution 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.

iv) 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 transmission 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 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. Therefore, all transmission to distribution interconnection requests greater than 100 kV to the DPC Transmission System are subject to the processes and procedures required by the MISO Tariff.

The MISO is the NERC Planning Authority for its member footprint and performs regional planning in accordance with FERC Planning Principles defined in FERC Order 890. These planning principles provide a process to ensure that the regional transmission planning process is open, transparent, coordinated, includes both reliability and economic planning considerations, and includes a process for equitable cost sharing of expansion costs.

MISO, through the regional planning process, integrates the local planning processes of its member companies and the advice and guidance of stakeholders into a coordinated regional transmission plan. MISO's regional planning process will identify additional transmission facilities to provide for an efficient and reliable transmission system that delivers reliable power supply to connected load customers, better integrates the grid, alleviates congestion, provides access to diverse energy resources, and enables state and federal energy policy objectives to be met. This MISO planning process is called the MISO Transmission Expansion Plan (MTEP) process. By placing this interconnection in the MTEP process informs those entities responsible for the reliability of the affected systems due to these new or materially modified facilities. Since all DPC's facilities are within MISO's footprint, interconnections to DPC facilities are within the MISO BA's area metered boundaries.

II) INTERCONNECTION PROCESS

a) Transmission to Distribution (T-D) Interconnection Process

i) Distribution Substation/End Use Customer Interconnection Application

A distribution project developer that seeks to interconnect or modify its project to the DPC Transmission System must fill out this interconnection form, which is available on the Dairyland Power website (http://www.dairylandpower.com/content/interconnection-guidelines-and-forms) and then submit the form as outlined on the website.

ii) Interconnection Study Process

The distribution project developer must provide the following interconnection information: initial Point of Interconnection (POI), MW load, MVAR load, 10-year load forecast, protection equipment, equipment ratings, capacity needs, timelines, and other information required for the interconnection. This initial interconnection information will determine the final facility ratings and allow appropriate system modeling of the interconnection facility.

After the distribution project developer has provided this information, DPC will then perform an interconnection study at the requestor's expense. The facility equipment ratings for the new and existing facilities, final POI, MVAR compensation (example: capacitor banks) and voltage level will be determined based on the results of the interconnection study.

In the interconnection study, DPC and the distribution project developer will define the terms and conditions under which DPC will construct the interconnection facilities and upgrade portions of its existing transmission system. The interconnection study will also allocate the costs of these interconnection facilities and system upgrades between the developer and DPC. The interconnection study will prescribe the design requirements for interconnection of the distribution project developer's interconnection facilities.

b) Notification of New or Modified Facilities

Upon completion of the interconnection study and acceptance of the required interconnection facilities, DPC and the distribution project developer shall notify the reliability entities of the modified existing or new transmission facilities required for this transmission to distribution interconnection. To implement this requirement, DPC and the distribution project developer shall submit the data related to these new or modified facilities to the MISO model building process. For new or modified transmission facilities that are greater than 100 kV, DPC and the distribution project developer shall submit the interconnection information to the MISO MTEP process. The "MISO Business Practices Manual Transmission Planning BPM-020" defines how to submit this data into the MTEP process.

c) Transmission to Distribution Interconnection Agreement (T-D IA)

DPC will not commence with engineering, procurement, construction or installation of any facilities related to the distribution project developer's interconnection, until the T-D IA is executed between DPC, the distribution project developer, and if applicable MISO. Once the T-D IA is executed, DPC will proceed with the interconnection process and the T-D IA will be filed with the applicable regulatory agency, if required.

III) INTERCONNECTION TECHNICAL/ DESIGN REQUIREMENTS

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

a) Substation

A distribution 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 the physical interconnection point and the performance of the DPC Transmission System with the proposed interconnection. DPC uses three standard substation configurations in various parts of its system; straight bus, ring bus, and breaker and a half. If the distribution 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.

i) Site

If the interconnection is not at an existing DPC substation, the distribution project developer must provide a site. If the interconnection is at an existing DPC substation, the distribution 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 as determined in the interconnection study to accomplish the interconnection.

ii) Disconnect/Interconnection Switch

A disconnect device must be installed to isolate the DPC Transmission System from the proposed interconnection. This disconnect device shall be procured, installed and owned by the distribution project developer at their expense. The disconnect device shall provide a visible air gap to establish required clearances for maintenance and repair work on 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 would normally be placed inside the substation site owned by the project developer. If there are constraints that prohibit the disconnecting device from being located within the project developer's site, then the project developer must locate and own the disconnecting device within eyesight of the substation.

The disconnecting device shall always be accessible 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 distribution project developer shall not remove any padlocks or DPC safety tags. The distribution project developer shall provide access to disconnects always (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.

iii) 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)	Specific to interconnection
Required Bus Ampacity	Specific to interconnection
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 distribution project developer

Foundation Design

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

iv) 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 fabric plus a minimum of 1 foot vertical height of barbed wire</u>, mounted at 45 degree angle, mounted outward from the substation.

v) 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 maybe required in order to maintain certain station auxiliaries in an operable condition.

vi) 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.

vii) 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).

viii) Lighting

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

ix) Safety Grounding

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

The distribution 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

For the interconnection study, the distribution project developer shall provide DPC with model data which includes, but is not limited to, equipment ratings, one-line diagrams, impedance values, voltage level, MW capacity, MVAR capacity and short-circuit data. 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, short-circuit and transient stability simulation of the new distribution interconnection.

The distribution project developer has an ongoing requirement to provide DPC with changes to the interconnection. These changes may include model data for the proposed interconnection and any associated power conversion equipment and protective devices, for potential use with the EPRI/DCG Electromagnetic Transients Program ("EMTP") and a short circuit protection program like CAPE.

c) Power Factor and Reactive Power

The distribution project developer will generally be expected to maintain the power factor greater than 98% lagging or leading, using reactive power sources such as shunt capacitors or shunt reactors. The distribution project developer must provide their own reactive support for their interconnection facilities according to good utility practice and not be a burden on the DPC Transmission System.

d) Power Quality Requirements

i) Voltage

For steady state voltage requirements, the distribution project developer should expect normal operating voltage of +/- 5% from nominal and contingency operating voltage of +/- 10%. The interconnection should be able to operate whenever the voltage at the points of interconnection are within the +/- 10% of nominal range.

Consistent with DPC Planning Study Criteria, the DPC Transmission System is designed to avoid experiencing dynamic voltage dips below 70% due to external faults or other disturbance initiators. Due to power system dynamic response characteristics, such as dynamic under voltage, occurrences may be experienced repetitively in a back-to-back manner. High voltage swings of up to 120% are also possible.

ii) Flicker

Distribution 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 distribution project developer shall be responsible and liable for corrections if the interconnection is the cause of objectionable flicker levels.

iii) Harmonics

The distribution 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 interconnection and the DPC Transmission System and be within the limits specified in the tables below. DPC advises that the distribution 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 the distribution project developer and the utility

From: IEEE 519 Table 10.3

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 distribution 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 Transmission System from the distribution project developer's facilities. Any reasonably incurred expenses (by DPC or others) to facilitate or implement remedial actions shall be reimbursed by distribution project developer.

e) Frequency Requirements

The energy exchanged at the POI shall be 60 Hz sinusoidal alternating current at a standard voltage, with the correct phase rotation. The distribution project developer must verify the correct rotation and voltage in the area before purchasing any equipment for the interconnection.

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 the developer's equipment causes these fault current limits to be exceeded, the distribution 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 distribution 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 interconnection study. The distribution project developer shall work closely with DPC at the time of interconnection design to determine the available fault current at the specific interconnection location.

g) Fault Detection and Clearing/Breaker Duty

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

The distribution project developer shall provide and maintain systems capable of interrupting maximum fault levels on the developer's equipment and the DPC Transmission System. Fault interrupting equipment such as circuit breakers, circuit switchers, fuses, etc., shall be capable of interrupting present and future available fault currents at the location at which they are being installed. Fault currents may increase on the DPC Transmission System over time, the distribution 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.

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 distribution 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 distribution project developer shall ensure that all equipment is adequately protected from excessive system over-voltages. This includes selection of equipment Basic Impulse 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 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 the disconnect switch. DPC specifications for surge arresters are available upon request.

j) Synchronization to the DPC Transmission System

The distribution project developer and DPC will use good utility practice for synchronization of the distribution facilities at the POI. This is especially true when distribution generation is connected to the developer's distribution system. DPC is not responsible for the appropriateness of the distribution project developer's synchronization relaying. It is highly recommended that the distribution project developer consult with the equipment suppliers or manufacturers for the settings that are appropriate for the protection of the distribution project developer's and DPC's equipment.

k) System Restoration

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 distribution project developer must coordinate with the system restoration plan in accordance to good utility practice.

l) 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.

m) Supervisory Control and Data Acquisition (SCADA) for Interconnection 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
- Capacitor/Reactor status
- Other points as necessary to provide comparable control and indication to the DPC control standard

n) Emergency Load Shedding Requirements

DPC is required to shed load in emergencies to meet NERC and MRO requirements. These requirements may include automatic or manual load shedding requirements. MRO requires automatic under-frequency load shedding of DPC load at the following levels:

- 59.3 Hz 10% of total DPC load shed
- 59.0 Hz 20% of total DPC load shed
- 58.7 Hz 30% of total DPC load shed

A distribution project developer maybe required to install equipment for under-frequency load shedding as required by MRO.

IV) PROTECTIVE DEVICES

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

Protective devices, such as protective relays, circuit breakers, circuit switchers, fuses, etc., shall be installed by the distribution project developer to disconnect the interconnection facilities 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 distribution project developer's equipment
2. The location of the interconnection facilities on the DPC Transmission System
3. The system voltage level of the distribution project developer's facilities

Protective devices are required to promptly sense abnormal operating or fault conditions and initiate the isolation of the faulted area. The specific requirements will be determined in the interconnection study.

a) Protective Relays and Coordination

   Protective relays will sense abnormal operating or fault conditions and initiate the isolation of the faulted area. The distribution 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 distribution 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 distribution project developer is responsible for the design of protection schemes protecting the distribution project developer's facilities.

b) Relay Protection Function Requirements

   The following protective relay recommendations may be necessary for DPC to supply its members and customers with a stable electrical system.

   1. Relay Requirements

      These functions will protect DPC's equipment and its members' 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 relays that may be required:

      - Impedance (21) - Where over current functions may not be adequate.
      - Breaker Failure (50BF)
      - Bus Differential (87)
      - Transformer Differential (87)

- Transfer Trip (TT)
- Directional Overcurrent (67)
- Over/Under Voltage (27/59)
- Ground Over Voltage (59 G) - ground fault protection for an ungrounded system at the distribution project developer's facilities
- Over Current (51, 51V) - for faults and overloads
- Synchronizing and reclosing relays (25)
- Pilot Protection

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 interconnection facilities from the DPC Transmission System due to a fault or other abnormal conditions which cannot be sensed by the protective devices at the distribution 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 of DPC's side of the interconnection. Details of the requirements will be documented in the interconnection study.

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.

V) METERING AND TELEMETRY

DPC and the distribution project developer are required to provide interchange metering such that the delivery of power and energy to the distribution project developer's interconnection can be determined. The interchange metering/recording devices shall be capable of remote communication. This remote interrogation will require the installation of a communication line. The communication line may be an existing telephone line, microwave circuit, fiber optics, etc. The communication and metering requirements will be stated in the interconnection study.

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.

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 distribution project developer shall be electrically connected at the point of interconnection (POI).

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 distribution project developer to achieve an installation which meets the requirements of both the distribution project developer and DPC. The distribution project developer shall bear the costs of metering and telemetry modifications required to permit the operation of the distribution interconnection.

d) Energy Losses

If the energy is not metered at the POI where the energy exchange between DPC and the distribution project developer has been defined by the interconnection study, energy losses must be determined from the metering point to the POI. Accounting for these losses shall be done 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 package. 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 distribution project developer cease all operation of the interconnection tie 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 for real time visibility of the DPC Energy Management System (EMS) 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 interconnection 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 interconnection study.

VI) FACILITY INTERCONNECTION REQUIREMENTS AND INSPECTION

Prior to the actual operation of the new interconnection with the DPC Transmission System, all pertinent contracts shall be signed, and all new equipment installations and modifications shall be complete. In addition, the distribution 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 interconnection study.
- Verification of the proper operation of the protective schemes.
- Verification that the proper voltages and currents are applied to the interconnection protective devices.
- Verification of proper operation and settings of the interconnection protective devices.
- Verification of synchronizing equipment if required.
- 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 distribution 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 distribution project developer and DPC as soon as practical.

Upon performance and certification of the interconnection inspection, the distribution project developer shall be granted approval for operation of the interconnection facilities with the DPC Transmission System. Neither the inspection nor the granting of approval to the distribution project developer shall serve to relieve the distribution project developer of any liability for injury, death or damage attributable to the negligence of the distribution project developer. The inspection and approval do not constitute a warranty or relieve the distribution project developer of responsibility for the operating condition or installation of the equipment and may not be relied upon by the distribution project developer for that purpose. If the operation of the interconnection facilities is 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 distribution 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 for testing 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 distribution 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 distribution project developer's premises, an inspection of the work area may be made by DPC operating personnel. If hazardous working conditions are detected, the distribution project developer shall be required to correct the unsafe conditions before DPC will perform the work.

VII) OPERATING GUIDELINES

The distribution project developer shall operate the interconnection facilities within the guidelines of this document and any special requirements set forth by established agreements.

a) Normal Conditions and Communications

The distribution project developer and DPC shall operate the transmission system at the POI according to good utility practice.

With the interconnection in-service, the distribution project developer's equipment events or actions may impact the DPC Transmission System. DPC's system events may impact the distribution project developer's new interconnection. Consequently, communication between parties is of the utmost importance. A DPC representative shall provide the distribution 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. Likewise, the distribution project developer shall provide DPC with the names and phone numbers of the distribution project developer's contact(s) with responsibility for operating their system.

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

- Substation equipment problems are detected that could result in mis-operation of the relay protection or other equipment.
- Substation equipment problems result in an outage to a portion of the DPC Transmission System.
- The distribution project developer intends to initiate switching to energize the interconnection with the DPC Transmission System.
- The distribution project developer intends to open the interconnection between its system and the DPC Transmission System.

b) Abnormal Conditions and Communications

DPC and the distribution project developer will communicate and coordinate during abnormal conditions. However, DPC retains the right to open the interconnection tie circuit breaker or disconnect device at the POI for any of the following reasons, but will coordinate those actions with the distribution project developer after execution:

- DPC performing emergency line work on the DPC Transmission System.
- DPC Transmission System emergency.
- Inspection of distribution project developer's equipment and protective devices reveals a hazardous condition.
- Failure of the distribution project developer to provide maintenance and testing reports when required.
- The distribution project developer's equipment interferes with other DPC members or customers or with the operation of the DPC Transmission System.
- The distribution project developer has modified the protective devices without the knowledge or approval of DPC.
- Operation of any unapproved distribution project developer's equipment.
- Personnel and/or public safety is threatened.
- Failure of the distribution 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 distribution project developer of any liability for injury, death or damage attributable to the negligence of the distribution project developer.

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

c) Maintenance Notification/Coordination

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

- Interconnection equipment operating capability due to equipment ratings limitations.
- 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 distribution 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.

VIII) 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.

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.

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 distribution project developer owned breaker which connects DPC source of power to the distribution project developer’s bus.

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

Interconnection Facilities: The facilities required to make the physical connection between the distribution project developer and the DPC transmission system. This may include new substation and transmission facilities as well as other system upgrades to be owned by DPC.

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.

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.

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

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

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

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.

IX) 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.

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

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

POWER TRANSFORMERS

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

CIRCUIT BREAKER/RECLOSER TESTS

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

Document Review

FAC-001 --- Transmission to Distribution Interconnection Guidelines

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Standard Owner: Amanda Kastenschmidt

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Yearly Review	Terry Torgerson	Jerry Iverson	12/2014
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