

Midwest Reliability Organization Procedure for Disturbance Monitoring and Reporting Requirements

A. Introduction - The following procedure developed by the MRO Protective Relay Subcommittee is considered a technical guideline and should be followed as good utility practice.

- 1. Title:** **Define Regional Disturbance Monitoring and Reporting Requirements**
- 2. Number:** **NERC Standard PRC-002-1**
- 3. Purpose:** Ensure that Midwest Reliability Organization (MRO) establishes requirements for installation of Disturbance Monitoring Equipment (DME) and reporting of Disturbance data to facilitate analyses of events and verify system models. For the purposes of this PRC, DME includes Sequence of Events Recorder (SER), Digital Fault Recorder (DFR) and Dynamic Disturbance Recorder (DDR).
- 4. Applicability:** Midwest Reliability Organization, Generation and Transmission Owners.
- 5. Effective Date:** January 15, 2008.

B. Requirements

R1. The Midwest Reliability Organization establishes the following installation requirements for sequence of event recording:

Sequence of events recorders are devices capable of monitoring and recording system data pertaining to a “disturbance”. They record equipment response to the event. Sequence of events recorders shall be any device capable of recording each “change of state” of its “on/off” inputs and tagging each change of state with a “precise time” and have “local data retention” as specified in the latest revision of PRC-018 or its successor.

Acceptable equipment includes stand alone sequence of event recorders; fault recorders capable of being triggered, recording and retaining sequence of event data, micro-processor based relays capable of being triggered, recording and retaining sequence of event data; data loggers with the required capabilities; some SCADA RTUs or other equipment that includes the required capabilities.

Sequence of Event recorders shall be equipped with a GPS synchronized time source for time and date stamping.



R1.1. Location, monitoring and recording requirements including the following:

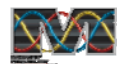
R1.1.1. Criteria for equipment location (e.g., by voltage, geographic area, station size, etc.).

The following are MRO regional locations where sequence of event data shall be recorded:

1. HVDC transmission facilities.
2. Generation facilities with an aggregate nameplate rating equal to or above 300 MW regardless of voltage level.
3. Facilities 200kV and above, or operationally critical facilities between 100 and 200 kV ^[1], which are:
 - a. Locations where out of step tripping is initiated.
 - b. Intertie lines between Load Control Areas.
 - c. All 345 kV and above substations.
 - d. Locations with a combined total of four (4) or more transmission lines or transformers. Include transmission lines of 200 kV and above. Include transformers having secondary voltage ratings of 100kV and above.
 - e. Special Protection Systems.
 - f. Specialized power system devices such as dynamically switched capacitors, phase shifting transformers and Flexible AC Transmission (FACTS) devices.

R1.1.2. Devices to be monitored

1. Where monitoring in R1.1.1 is required, the following shall be monitored:
 - a. Transmission lines operated at 200kV or above.
 - b. Transmission buses operated at 200kV or above.
 - c. Transformers having primary and secondary voltage rating of 200kV or above.
 - d. Critical facilities between 100 and 200kV^[1].
 - e. Generation delivery point to the transmission system.



2. As a minimum, the following specific functions to be monitored include:
 - a. Circuit Breaker Position.
 - b. Sending and/or Receiving of Communications in aid to protective relaying.
 - c. Breaker Failure Trip.
 - d. Initiation of a Special Protection System Action.
 - e. Sending and/or Receiving of Communications in aid to Special Protection Systems.
 - f. Special Protection System Functions that may be considered “key” to forensic analysis of the event.

R2. The Midwest Reliability Organization shall establish the following installation requirements for fault recording:

Fault recorders are devices capable of monitoring and recording system data pertaining to a “disturbance”. Fault recorders record actual waveform data replicating the system primary voltages and currents. These event recordings are short duration, high sample rate recordings required for power system fault disturbance analysis. Fault recorders shall tag each event record with a “precise time”, and shall have “local data retention” as specified in the latest revision of PRC-018 or its successor.

Acceptable equipment includes stand alone fault recorders, and micro-processor based relays that comply with the recording length and minimum sampling rates specified below.

Fault recorders shall be equipped with a GPS synchronized time source, for time and date stamping.

R2.1. Location, monitoring and recording requirements including the following:

R2.1.1. Criteria for equipment location (e.g., by voltage, geographic area, station size, etc.).

The following are MRO regional locations where fault data shall be recorded:

1. HVDC transmission facilities.
2. Generation facilities with an aggregate nameplate rating equal to or above 300 MW regardless of voltage level.



3. Facilities 200kV and above, or operationally critical facilities between 100 and 200 kV^[1], which are:
 - a. Locations where out of step tripping is initiated.
 - b. Intertie lines between Load Control Areas.
 - c. All 345 kV and above substations.
 - d. Locations with a combined total of four (4) or more transmission lines or transformers.
Include transmission lines of 200 kV and above.
Include transformers having secondary voltage ratings of 100kV and above.
 - e. Special Protection Systems
 - f. Specialized power system devices such as dynamically switched capacitors, phase shifting transformers and Flexible AC Transmission (FACTS) devices.

R2.1.2. Elements to be monitored at each location.

Where monitoring in R2.1.1 is required, the following shall be monitored:

1. Transmission lines operated at 200kV or above.
2. Transmission buses operated at 200kV or above.
3. Transformers having primary and secondary voltage rating of 200kV or above.
4. Critical facilities between 100 and 200kV^[1].
5. Generation delivery point to the transmission system.

R2.1.3. Electrical quantities to be recorded for each monitored element shall be sufficient to determine the following:

- R2.1.3.1.** Three phase to neutral voltages.
- R2.1.3.2.** Three phase currents and neutral currents.
- R2.1.3.3.** Polarizing currents and voltages, if used.
- R2.1.3.4.** Frequency.
- R2.1.3.5.** Megawatts and megavars.

Recommended monitored or calculated data:

Transmission Lines

- Three phase to neutral voltages. Use as many line side phase voltages available.
- Three phase and residual current on all lines.
- Relay polarizing currents and voltages.



Substation Equipment

- Transformer phase and neutral currents.
- Three phase to neutral voltages. Use as many bus side phase voltages available.
- Capacitor bank and Static Var System (SVS) currents.

Generators

- Terminal voltages.
- Phase and neutral currents.
- Field voltage.
- Field current.

R2.2. Technical requirements, including the following:

R2.2.1. Recording duration requirements.

A minimum fault record length of 11 cycles is recommended, including a minimum of 2 cycles of predisturbance information.

R2.2.2. Minimum sampling rate of 16 samples per cycle.

R2.2.3. Event triggering requirements.

Event triggering may be selected from the following list and utilized as appropriate:

- Overcurrent.
- Apparent Impedance.
- MW Flow.
- Change of State of circuit breakers.
- Relay Operation.
- Under or Over Frequency.
- Under or Over Voltage.
- Rate of Change.
- Sending and/or Receiving of Communications in aid to protective relaying.
- Breaker Failure Trip.
- Initiation of a Special Protection System Action.
- Sending and Receiving of Communications in aid to Special Protection Systems.
- Other Special Protection System Functions that may be considered “key” to forensic analysis of the event.
- Other trigger options that may be available in the fault recorder for use.



- R3.** The Midwest Reliability Organization shall establish the following installation requirements for dynamic disturbance recording:

Dynamic Disturbance Recorders (DDRs) are devices capable of monitoring and recording system data pertaining to a “disturbance”. DDRs record incidents that portray power system behavior during dynamic events such as low frequency (0.1 Hz - 3 Hz) oscillations and abnormal frequency or voltage excursions. They are capable of recording the long term, slow response information required for power system stability analysis. DDRs shall tag records with a “precise time”, and shall have “local data retention” as specified in the latest revision of PRC-018 or its successor.

Acceptable equipment includes any device capable of recording the specified data for the long term recording duration and at the sample specified below. They may be “triggered” devices (See R3.2.1 below) or “continuous record” devices. DDR capability is often included with some stand alone DFR equipment. DDR capability is also included with a few particular micro-processor based relays. (Check capability requirements below before applying.)

Dynamic Disturbance Recorders shall be equipped with a GPS synchronized time source, for time and date stamping.

- R3.1.** Location, monitoring and recording requirements including the following:

- R3.1.1.** Criteria for equipment location giving consideration to the following:

- Site(s) in or near major load centers.
- Site(s) in or near major generation clusters.
- Site(s) in or near major voltage sensitive areas.
- Site(s) on both sides of major transmission interfaces.
- A major transmission junction.
- Elements associated with Interconnection Reliability Operating Limits.
- Major EHV interconnections between Balancing Authorities.
- Coordination with neighboring regions within the interconnection.

The following are MRO regional locations where dynamic data shall be recorded. However, a DDR which is required at a transmission substation per requirements R3.1 shall be considered optional if a DDR (meeting all requirements of



R3.2) is found to be located one or two transmission substations away at a common voltage.

1. HVDC transmission facilities.
2. Generation facilities with an aggregate nameplate rating equal to or above 850 MW regardless of voltage level.
3. Major Metro areas having a total maximum load of 2500 MW or higher (at least one DDR).
4. Facilities 200kV and above, or operationally critical facilities between 100 and 200 kV ^[1], which are:
 - a. Locations where out of step tripping is initiated.
 - b. At one end of transmission lines having Interconnection Reliability Operation Limits (IROL) [See NERC glossary of terms for definition of “IROL”].
 - c. Locations with a total of four (4) or more transmission lines of 345 kV and above.
 - d. Locations with a total of six (6) or more transmission lines of 200 kV or above.
 - e. Special Protection Systems.
 - f. Specialized power system devices such as dynamically switched capacitors, phase shifting transformers and Flexible AC Transmission (FACTS) devices.
 - g. Dynamic study, system protection and generation working groups within MRO may identify other specific locations where DDRs shall be required.

R3.1.2. Elements and number of phases to be monitored at each location.

Where monitoring in R3.1.1 is required, DDRs shall record at minimum one phase of voltage and the same phase of current of the following system elements:

1. Transmission lines operated at 200kV or above.
2. Transmission buses operated at 200kV or above.
3. Transformers having primary and secondary voltage rating of 200kV or above.
4. Critical facilities between 100 and 200kV ^[1].
5. Generation delivery point to the transmission system.



R3.1.3. Electrical quantities to be recorded for each monitored element shall be sufficient to determine the following:

R3.1.3.1. Voltage, current and frequency.

R3.1.3.2. Megawatts and megavars.

R3.2. Technical requirements, including the following:

R3.2.1. All devices installed after January 1, 2009 shall have the capability for continuous recording.

R3.2.2. Each device shall sample data at a rate of at least 960 samples per second and shall record the RMS value of electrical quantities at a rate of at least 6 records per second.

Specific requirement for new installation:

Time Duration A minimum record duration of 30 seconds shall be used for recorders configured with single event recording capability.

R4. The Midwest Reliability Organization shall establish requirements for facility owners to report disturbance data recorded by their DME installations. The disturbance data reporting requirements shall include the following:

R4.1. Criteria for events that require the collection of data from DMEs:

Data shall be collected for power system events that cause a regional network Disturbance, or if requested by the MRO or any other affected regional entity, the DME owner shall collect recorded data which directly affected the power systems.

R4.2. List of entities that must be provided with recorded Disturbance data.

Disturbance data shall be provided to affected regional entities requesting the available data.

It shall be the MRO's responsibility to distribute the Disturbance data further as needed.

R4.3. Timetable for response to data request shall be thirty (30) calendar days of the day it was requested.



R4.4. Provision for reporting Disturbance data:

The data shall be in a format which is capable of being viewed, read and analyzed with a generic COMTRADE (IEEE C37.111-1999 IEEE Standard Common Format for Transient Data Exchange for Power Systems or its successor standard) analysis tool.

R4.5. Naming of data files shall be in conformance with the IEEE C37.232 Recommended Practice for Naming Time Sequence Data Files.

R4.6. Data content requirements and guidelines shall be in accordance with R4.4 and R4.5 or other formats deemed acceptable by the MRO.

R5. The Midwest Reliability Organization shall provide its requirements and any reporting to the affected Transmission Owners and Generator Owners within thirty (30) calendar days of approval of those requirements.

R6. The Midwest Reliability Organization shall periodically (at least every five years) review, update and approve its Regional requirements for Disturbance monitoring and reporting.

As part of the regional plan, the MRO Transmission Assessment Subcommittee shall maintain a list of existing dynamic disturbance and critical fault recorder locations.

C. Measures

M1. The Midwest Reliability Organization's requirements for the installation of Disturbance Monitoring Equipment shall address Requirements 1 through 3.

M2. The Midwest Reliability Organization's Disturbance monitoring data reporting requirements shall include all elements identified in Requirements 4.

M3. The Midwest Reliability Organization shall have evidence it provided its Regional Disturbance monitoring and reporting requirements as required in Requirement 5.

M4. The Midwest Reliability Organization shall have evidence it conducted a review at least once every five years of its regional requirements for Disturbance monitoring and reporting as required in Requirement 6.



D. Compliance

1. NERC PRC-018 requires that an entity complies with regional requirements established per NERC PRC-002-1 and monitors compliance relative to those regional requirements.
2. Violation Severity Levels Refer to NERC PRC-018 for both Violation Severity Levels and Levels of Non-Compliance.

Notes:

- [1] The NERC suggested guidelines for Critical Circuit definition are as follows:
- a. All circuits that are elements of the NERC Book of Flowgates unless the Transmission Owner excludes them. This includes both the monitored and outage element for OTDF ^[2] sets.
 - b. All circuits that are directly related to off-site power supply to nuclear plants. Any circuit whose outage causes unacceptable voltages on the offsite power bus at a nuclear plant must be included, regardless of its proximity to the plant.
 - c. Other circuits determined and agreed to by the transmission owners, reliability authority/coordinator and the RROs.
- [2] Outage Transfer Distribution Factor (OTDF) Flowgates are Flowgates that take into account a predefined contingency during curtailment evaluation. With OTDF Flowgates the monitored branches are considered with a specific facility removed from service during curtailment evaluation.

