
Review of NERC Planning Standards for Disturbance Monitoring

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Introduction

The new competitive electricity environment is fostering a rapidly changing demand for transmission services. With this focus on transmission and its ability to support competitive electric power transfers, all users of the interconnected transmission systems must understand the electrical limitations of the transmission systems and their capability to support a wide variety of transfers. The North American Electric Reliability Council (NERC) Planning Standards were developed due to these changes and the need to maintain the reliability of the bulk electric systems.

This paper will review the North American Electric Reliability Council (NERC) standards process and provide some details on how they are organized, implemented and who they apply to in the electric power system. The standards cover very large aspect of planning and operations, but this paper will concentrate primarily on those standards that apply to disturbance monitoring.

NERC

The North American Electric Reliability Council (NERC) was formed in 1968 to promote the reliability of the bulk electric system in North America. To achieve that purpose, NERC has developed and promulgated reliability standards for planning and operating the bulk electric systems. These standards were developed and implemented over a number of years through the voluntary and cooperative efforts of NERC's member Regions. With the continued growth of competition and the structural changes taking place in the industry, incentives and responsibilities are changing, making it necessary for NERC to transform itself from a voluntary system of reliability management to one that is mandatory. NERC, through its Regions, is embarking on a program to assess and enforce compliance with its reliability standards. Each of the NERC Regions have implemented their own Regional Compliance Enforcement Programs to achieve this goal.

NERC's objectives are to:

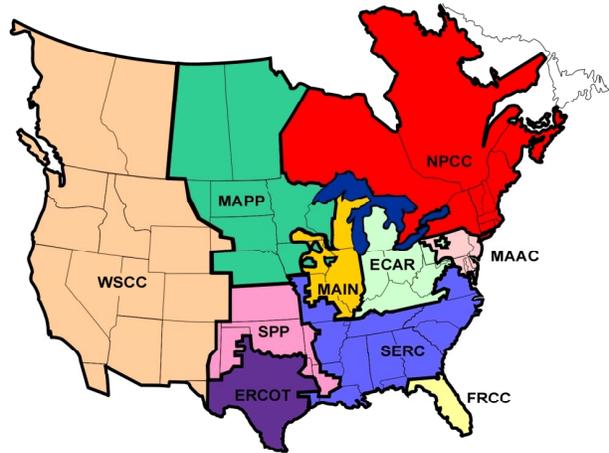
- Establish operating and planning standards to ensure electric system reliability.
- Reviews the reliability of existing and planned generation and transmission systems.
- Critiques past electric system disturbances for lessons learned and monitors the present for compliance and conformance to its policies.
- Educate others about how bulk electric systems operate.
- Maintain liaisons with the federal, state, and provincial governments in the United States and Canada and electricity supply industry organizations in both countries.
- Serves as the electric industry's primary point of contact with the federal government on issues relating to national security and terrorism.

NERC is made up of 10 regional councils, with members from all segments of the electric industry. Members come from: investor-owned utilities; federal power agencies; rural electric cooperatives; state, municipal and provincial utilities; independent power producers; power marketers; and end-use customers. These entities account for virtually all the electricity supplied in the United States, Canada, and a portion of Baja California Norte, Mexico.

NERC Planning Standards

The Planning and Operating Standards were developed to assure the adequacy and security of the bulk electric system. They define the reliability of the interconnected bulk electric system using the following terms:

- **Bulk Electric System** - portion of an electric utility system, which encompasses the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100 kV or higher.
- **Adequacy** - The ability of the electric systems to supply the aggregate electrical demand and energy requirements of their customers at all times, taking into account scheduled and reasonable expected unscheduled outages of system element.
- **Security** – The ability of the electric systems to withstand sudden disturbances such as electric short circuits or unanticipated loss of system elements.



NERC Reliability Regions

The planning standards, which contain the disturbance monitoring requirements, address how NERC will carry out its reliability mission by establishing the standard, measuring performance, and ensuring compliance with NERC policies, standards, principles and guides. The standards have four major sections:

- I. **System Adequacy and Security**
(Section F. contains the disturbance monitoring requirements.)
- II. **System Modeling Data Requirements**
- III. **System Protection and Control**
- IV. **System Restoration**

With open access to the transmission systems in connection with the new competitive electricity market, all electric industry participants must accept the responsibility to observe and comply with the NERC planning standards and to contribute to their development and continuing improvement. That is, compliance with the NERC Planning Standards by the Regional Councils (Regions) and their members as well as all other electric industry participants is mandatory.

Standards Development Process

The process for each standard from development through compliance is very detailed and goes through a number of steps before it is finalized. The process is still “work in progress” and the processes and standards are being revised on a continual basis. Some of the original standards/measures have been revised, combined, re-numbered, or eliminated. It is important for the user to check the NERC and or region web site for the latest information. Important sites to check are the NERC compliance templates and the NERC planning standards-status. For SERC check the 2002 SERC Compliance Program Implementation Plan. The web sites addresses are listed in the in back of this paper.

Implementation Plan

The implementation of the planning standards are being done in several phases. Each phase will include a field test of the standard and measurements. After field testing the standard or measurement will be reviewed and revised if needed. The process was set up in four phases and started in 1999 with phase I. For 2002 the plan will be to field test a number of phase III standards as well as revised standards from phases I and II. Phase IV standards are still being revised and will be field tested in the future. See Table 1 for the status of the Disturbance Monitoring Standards

Compliance Program

The Regions, subregions, power pools, and their members have the primary responsibility for the reliability of bulk electric supply in their respective areas. These entities also have the responsibility to develop their own appropriate or more detailed planning and operating reliability criteria and guides that are based on the Planning Standards. This allows the regions to adjust for the diversity of individual electric system characteristics, geography, and demographics for their areas.

In order to determine compliance, NERC has developed templates for the regions to follow. The templates provide several levels of compliance for each measure and are used to rate the individual transmission provider or generation owner/operator. As each standard/measure is implemented, the transmission provider or generation owner/operator will be required to certify compliance. In some cases additional forms may also be required to document compliance. Some of these reporting forms include: reporting of protective system mis-operations, location of disturbance recording devices, or report of major system disturbances. These will be requested by the region and will be subject to an audit.

Components of the Planning Standard

There are several components or reporting activities associated with the process. Some of the components come from NERC and are developed and monitored by the regions. Below is a list of the components with an explanation of its purpose.

Standard-(NERC)

Each standard states the fundamental requirements for planning a reliable interconnected bulk electric system, and may have one or more measures to define the requirements.

Measurements-(NERC)

The Measurements define the required actions or system performance necessary to comply with the Standards. Provides the technical details to meet and to whom the measure applies.

Guides-(NERC)

The Guides are good planning practices and considerations that may vary. The Regions and their members along with all other electric industry participants are encouraged to consider and follow the Guides. The application of Guides is expected to vary to match load conditions and individual system requirements and characteristics.

Compliance Templates-(NERC)

One Compliance Template is written per each measure. It provides details such as: responsible entity, monitoring responsibility, items to be measured, timeframe for reporting, and levels of non-compliance.

Region Supplement-(Region)

Supplements are written by the region and define additional requirements or clarification for a specific standard/measure. In some cases it may apply to multiple standard/measures. These provide the technical details on the requirements, processes and reporting information as required by the region.

Reporting Forms-(Region)

Reporting forms are set up by the region and are defined in the region supplement. They include information on what to report, when to report and details of what needs to be reported.

Letter of Certification-(Region)

Letter of certification are forms developed by the region for the members to certify compliance to the standard/measure. They include check boxes for the member to certify as well as if additional information (reporting forms) is needed. An officer of the company MUST sign these forms.

SERC Example - Region Compliance Monitoring/Audits/Enforcement

Compliance monitoring will be accomplished by audits, spot reviews, investigations, and committee reviews of member self assessments, letters of certification, and data submittals. For 2002, audits of selected planning measures and entities will be conducted on a field test program basis, in which a limited number of audits will be conducted in order to incorporate changes and improvements to the process between audits. Audit teams will initially consist of experienced personnel from member systems. SERC may elect to utilize independent auditors for some or all subsequent audits to facilitate staffing of audit teams and to ensure an unbiased and consistent compliance monitoring program. The table in



appendix A provides a summary of the planning measures SERC will monitor in the compliance program and/or are subject to member audit by SERC.

The SERC Compliance Program uses the NERC Penalty/Enforcement Matrix; however, monetary penalties/sanctions will not be assessed during the 2002 Compliance Program. Field Test Letters will be sent to non-compliant members and to NERC and SERC committees. Members will, however, be notified of the penalties that would have resulted if the program had been enforceable.

Disturbance Monitoring Standards/Measures

The following sections will cover the details of the implementation of the disturbance monitoring standards/measurements as they apply to transmission and generation owners within the Reliability regions. Since NERC standards require the regions to define some of the measures, the following information may differ from other regions. Please refer to region web sites or their local region representative for details of that region. This paper will use the SERC implementation as a detailed example and reference aspects of the implementation from the other regions. The table below lists the standards and measurements that will be discussed in detail. The table provides information on responsible entry, reporting requirements, and status of measurement.

	Description	Responsible Entry	Reporting Form	Status
I. System Adequacy and Security F. Disturbance Monitoring				
M1	Disturbance Monitoring requirements	Region	Supplement	Approved (Note 1)
M2	Disturbance Monitoring Installation	Region member, Operators/Owners	Reporting Form, Letter of Certification	Field Testing 2001 (Note 2)
M3	Disturbance Monitoring Data requirements	Region	Supplement	Field Testing 2001 (Note 2)
M4	Providing Disturbance Monitoring Data	Region member, Operators/Owners	Reporting Form, Letter of Certification	Field Testing 2002 (Note 2)
M5	Using Disturbance Monitoring data to enhance system models	Region member, Operators/Owners		Phase IV (Note 3)

Table 1 – Status of Disturbance Monitoring Standards

Note 1: Phase I, II/A, and II/B measurements were field-tested and approved under the old NERC standards program. They remain in force until converted to NERC Organization Standards. Field-testing of these measurements were: Phase I in 1999, Phase II/A in 2000, and Phase II/B in 2000/01.

Note 2: Phase III measurements were field-tested in 2001 under the old NERC standards program. They will be converted to NERC Organization Standards prior to approval.

Note 3: Under the old NERC standards program, Phase IV measurements were scheduled to be revised, then field-tested in 2003. It has been decided that the Phase IV measurements will be converted to NERC Organization Standards prior to field-testing. It is not clear if this will occur by 2003.

Disturbance Monitoring Requirements

NERC Planning Standard Measurement I.F.S1.M1

Title: System Adequacy and Security, Disturbance Monitoring;

M.1 Region to define the requirements for the installation of Disturbance Monitoring Equipment.

SERC Region: The requirements are listed in SERC Supplement to the NERC Planning Standards “I.F – Procedures for the Installation and Collection of Event Data from Disturbance Monitoring Equipment.” The supplement also covers details for measurements 1-4 and can be found on SERC’s web site as listed in the back of the paper.

SERC defines disturbance recording equipment to include: digital fault recorders, digital relays, magnetic tape recorders, and oscillographs all of which are capable of producing fault records. The recorders should meet the following items:

Technical Requirements:

- Capable of producing fault wave forms
- Record voltages and currents
- Power circuit breaker position
- Time Synchronization preferred
- Minimum recording duration 8-10 cycles

Criteria for the location of monitoring equipment:

- New transmission elements 161 KV and above (Lines, Transformers)
- Monitoring one end of a transmission line is acceptable.
- Dynamic Disturbance Recorders (long term) as agreed to by SERC

Testing and maintenance requirements:

- Determined by region member

Documentation requirements:

- SERC reporting form in supplement

NERC Planning Standard Measurement I.F.S1.M2

Title: System Adequacy and Security, Disturbance Monitoring;

M.2 Requires the regional members, generation owners, and transmission owners to submit a reporting form to SERC/PCWG with the following data on the disturbance monitoring installations:

- Type of equipment
- Make and model of equipment
- Installation location
- Monitored facilities (lines, buses, etc.) and associated quantities (MW, Mvar, etc.)
- Operational status
- Date last tested

**SERC Disturbance Monitoring Equipment
Station Monitoring Devices**

“I.F – Procedures for the Installation and Collection of Event Data from
Disturbance Monitoring Equipment

1. **Reporting Utility:** _____ **Date:** _____

2. **Contact Person:**

Name	
Mailing Address	
City, State, Zip	
Interoffice Address	
Telephone #	

Example

3. **Location of Equipment**

Station Name	Device Type *	Make/Model	Operational Yes/No	Date Last Tested

* FR - Fault Recorder, SER-Sequential Events Recorder, DDR-Dynamic Disturbance Recording

NERC Planning Standard Measurement I.F.S2.M3

Title: System Adequacy and Security, Disturbance Monitoring;

M.3 Regions shall establish requirements for entities to provide disturbance monitoring data.

The data reporting requirements shall include the following:

1. Definition of “disturbance”
 - DOE reportable events (DOE Form EIA-417R) These events generally are load reduction, load loss or brownout conditions.
 - Tripping of multiply generating units over 300 MW’s
 - Events on the power system that significantly impacts individual utilities or a significant part of the SERC region.
2. General requirements for data format
 - Hardcopy reports in the form of graphs and text.
 - Electronic files in native equipment file format or IEEE comtrade standard
3. Data content requirements and guidelines
 - One line diagram
 - Diagrams of interconnected system
 - Annotation of printed graphs and text
 - Description of disturbance
4. Timetable for response to data request
 - 5 days
5. Requirements for the storage and retention of the disturbance data
 - 2 years on requested data
6. The process for the periodic review and approval of the Region’s disturbance monitoring data reporting requirements
 - 3 years

NERC Planning Standard Measurement I.F.S2.M4

Title: System Adequacy and Security, Disturbance Monitoring;

M.4 Regional members, generation owners, and transmission owners shall provide system disturbance data to the Regions in compliance with the respective Regional requirements identified in Measurement I.F. S2, M3. Disturbance data shall be provided to NERC within 30 business days. Typically, the data might consist of digital fault records, protective relay oscillographic data where available, and sequence of events records. Below is an example of the SERC data capture request from.

**SERC Data Capture Request Form
Collection of Real Time Data**

TO: Company Name: _____ Contact Name: _____	
FROM	Date of Request: _____
Co. Name	Example
Requestors Name	
Mailing Address	
City, State, Zip	
Interoffice Addr	
Telephone #	
Fax #	
E-mail Addr	
<p><input type="checkbox"/> Please provide the requested information for the disturbance as follows:</p> <p><input type="checkbox"/> Please archive (for future use) the requested information for the disturbance as follows:</p> <p>DATE OF DISTURBANCE: _____</p> <p>TIME OF DISTURBANCE _____</p> <p>DISTURBANCE NO. _____ Assigned by SERC (YR.#) i.e., (9801,9802,9803,...)</p> <p>BRIEF DESCRIPTION: _____</p>	

NERC Planning Standard Measurement I.F.S2.M5

Title: System Adequacy and Security, Disturbance Monitoring;

M.5 Regional members shall use recorded data from disturbance monitoring equipment to develop, maintain, and enhance steady-state and dynamic system models and generator performance models.

This measurement will to be implemented in 2003. Detail information on compliance will be addressed later.

SERC Disturbance Monitoring Standards Subject to Audit or being Monitored in 2002

The table below provides a summary of the disturbance monitoring measures SERC will monitor in the compliance program and/or are subject to member audit by SERC. Refer to the Program Matrix and Member Filing Requirements documents on the serc1.org website for further information.

Measure	Description	Monitored in 2002	Subject to Audit
I.F.S1.M2	System Adequacy and Security, Disturbance Monitoring, Equipment List	Yes	Yes
I.F.S2.M4	System Adequacy and Security, Disturbance Monitoring, Data	Yes	Yes

Documents from Three other Reliability Regions on Disturbance Monitoring Equipment:

ECAR Document: [ECAR Document No. 14](#) **Title** "Disturbance Monitoring Equipment" **Approved:** 7/27/98

Synopsis: This Document establishes requirements related to selection and use of disturbance monitoring equipment to permit adequate analysis of electrical disturbances.

The ECAR document is more general than the SERC document but it outlines the responsibilities of the ECAR transmission and generation owners as applied to Disturbance Monitoring Equipment.

MAAC Document: B6 **Title** "Requirements for Installation of Disturbance Monitoring Equipment"

Synopsis: This Document establishes requirements related to selection and use of disturbance monitoring equipment to permit adequate analysis of electrical disturbances. The Guide outlines the type of substations at 230 kV and above where fault recorders are required. The list of existing fault recorders from the Phase I compliance procedure is also in the document.

MAIN Document: Guide 12 **Title** "Disturbance Monitoring Systems" **Approved** July 17, 2000
Appendix A "Disturbance Monitoring Equipment"

Synopsis: This Document establishes requirements related to selection and use of disturbance monitoring equipment to permit adequate analysis of electrical disturbances.

Web Sites

Site	Description of Document	Locations
NERC	Home	http://www.nerc.com/
NERC	NERC Planning Standards PDF File (1997)	ftp://www.nerc.com/pub/sys/all_updl/p/c/pss/ps9709.pdf
NERC	Compliance Templates for the NERC Planning Standards	http://www.nerc.com/~filez/pss-psg.html
NERC	Planning Standards-Status Posting of all comments, changes and approvals	http://www.nerc.com/~pc/standards/
NERC	Link to all region web sites	http://www.nerc.com/~filez/pss.html
NERC	Glossary of terms used by NERC	http://www.nerc.com/glossary/
SERC	Home	http://www.serc1.org/
SERC	SERC Supplements	http://www.serc1.org/document.html
SERC	Compliance Programs	http://www.serc1.org/compliance.html
FRCC	Home	http://www.frcc.com/
FRCC	Disturbance Reporting Procedure	http://www.frcc.com/reports.htm
FRCC	FRCC Handbook-Provides detail on Compliance requirements	http://www.frcc.com/reports.htm
FRCC	Compliance Monitoring Programs	http://www.frcc.com/reports.htm
ECAR	Compliance Monitoring Programs	http://www.ecar.org/documents/
ERCOT	ERCOT Home Page	http://www.ercot.com/
MAAC	Home	http://www.maac-rc.org/
MAAC	Disturbance Monitoring	http://www.maac-rc.org/
MAIN	Compliance Monitoring	http://www.maininc.org/bg/bgidx.htm
MAAP	Home	http://www.mapp.org/
MAAP	Compliance Program	http://www.mapp.org/compliance/2002/index.html
NPCC	Home	http://www.npcc.org/
NPCC	Compliance Program	http://www.npcc.org/compliance.asp
SPP	Home	http://www.spp.org/Doc_Results.asp?Group_id=215
WSCC	Home	http://www.wsc.com/docs_pubs.html