

Subject: Reference Materials for Time-Synchronized Measurements Training

Date: July 22, 2019

Purpose: Identify reference materials for the *Use of Time-Synchronized Measurements in the Real-Time Operations Horizon* training course.

North American SynchroPhasor Initiative (NASPI) Materials – Primary Source

[NASPI Website](#) – This link takes you to the NASPI website. The following Control Room Solution Task Team (CRSTT) work products were used to inform the time-synchronized measurements training and can be found on the [NASPI Website CRSTT Page](#):

Video Event Files – NASPI CRSTT has created 15 video event files that capture data from system events where synchrophasor data helped to identify and address abnormal system behavior. Links to these videos can be found under the “Videos” section of the CRSTT page.

[Video 1](#), [Video 3](#), [Video 5](#), [Video 7](#), [Video 10](#) and [Video 14](#) are included in the time-synchronized measurements training.

Operational Use Cases – NASPI CRSTT has created a series of operational use case documents to demonstrate ways that electric utilities are using synchrophasor data to provide operational value. Links to these cases can be found under the “Documents” section of the CRSTT page.

[GEN-003 – AVR Malfunction](#) and [GEN-005 – Nuclear Plant Oscillations](#) are included in the time-synchronized measurements training.

Focus Area Documents – NASPI CRSTT has created a series of focus area documents that explore the following areas of interest:

1. [System Islanding Detection and Blackstart Restoration](#) – June 2015.
2. [Using Synchrophasor Data for Voltage Stability Assessment](#) – Nov. 2015.
3. [Using Synchrophasor Data for Phase Angle Monitoring](#) – May 2016.
4. [Using Synchrophasor Data for Oscillation Detection](#) – Feb. 2018.
5. [Using Synchrophasor Data to Determine Disturbance Location](#) – Feb. 2019.

Links to these papers can be found under the “Documents” section of the CRSTT page. Each of these papers helped to inform the time-synchronized measurements training.

NERC Synchronized Measurements Subcommittee (SMS) Materials – Primary Source

[NERC Website SMS Page](#) – This link takes you to the NERC SMS website. The following papers are used as sources of information for the time-synchronized measurements training course:

[NERC Phase Angle Monitoring Technical Reference Report](#) – Provides an update on industry practices for phase angle difference monitoring and limit determination, phase angle-related applications and operating experience using innovative software tools.

[NERC Interconnection Oscillation Analysis Reliability Assessment](#) – Provides technical reference material focusing on system modes of oscillation and assessments of both natural and forced oscillations using time-synchronized measurement data for actual system events.

[NERC Forced Oscillation Event Analysis – January 2019 Event](#) – Provides info on an oscillation event that occurred in the Eastern Interconnection. Links to YouTube videos that display the event with synchrophasor-based apps are provided. This is the video we watched during the train-the-trainer session: <https://www.youtube.com/watch?v=xilfYKxqEDo&feature=youtu.be>.

Additional Reference Materials – Secondary Source

The following documents and reports were also used to inform the time-synchronized measurements training:

[NASPI Technical Report - Diagnosing Equipment Health and Mis-operations with PMU Data](#) – Shows the wide variety of events and equipment for which synchrophasor data have been used as a diagnostic tool and explains why each incident had actual or potential adverse reliability or cost impacts. Also, here's a link to an [Event Summary Table](#) that summarizes each of the events found in the report.

[NERC Real-Time Application of Synchrophasors for Improving Reliability Report](#) – Reviews the ways that synchrophasor technology can be used to support real-time and off-line activities to enhance the reliable operations of the bulk power system.

[Smart Grid Demonstration & Research Investigation Lab's Synchrophasor Technology Tutorial](#) – This series of videos provides an introductory tutorial to synchrophasor technology.

[WECC JSIS Modes of Inter-Area Power Oscillations in Western Interconnection](#) – Provides a summary of the major modes of inter-area oscillation in the Western Interconnection.

[NASPI Technical Report - The Value Proposition for Synchrophasor Technology](#) – Provides a methodology for identifying and estimating the benefits of using synchrophasor technology to enhance grid operations and planning.