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United States Government **Department of Energy**

Bonneville Power Administration

memorandum

DATE: July 2, 2008

REPLY TO ATTN OF: TPM/DITT2

SUBJECT: Performance Validation and Noise Injection Staged Tests

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1. Summary and Objectives

The Bonneville Power Administration (**BPA**) is planning comprehensive probing tests of WECC system dynamics under summer conditions. This test will be performed in coordination with WECC technical groups such as the DMWG and M&VWG, and is scheduled for August 12, 2008 with alternate days of August 13, 19 and 20 that may be used in the event that the test date must be changed or portions of the test must be repeated. Dates may be revised by System Operations to meet system requirements.

The test will include the following staged events:

- Energization of the Chief Joseph dynamic brake
- Insertion of brief intermediate level ±125 MW waves by modulation of the Pacific HVDC Intertie
- Insertion of sustained pseudo-random noise by modulation of the Pacific HVDC Intertie

The main objectives of these tests include the following:

A. Obtain seasonal benchmarks for dynamic performance of the WECC system
B. Develop comparative data to evaluate and refine the realism of WECC modeling tools
C. Refine and validate methods that identify power system dynamics with minimal or no use of probing signals
D. Test performance of the replacement probing signal generator (PSG)
E. Evaluate effectiveness of low level probing for load identification

Close examination of system behavior will be made before and throughout the test to confirm that system conditions are suitable for testing, and that the test is proceeding as expected. WECC members having a PDC StreamReader are invited to participate in this, and to use associated spectral analysis software to observe frequency domain signatures for their service areas. Alternate toolsets for this include Real Time Dynamic Monitor System (RTDMS) and the DOE ModeMeter. Extended data access at the California ISO and at the Pacific Northwest National Laboratory permits almost total backup there to BPA for test monitoring.

WAMS data from this test will be recorded automatically. However, it is necessary that the operators of the measurement facilities assure that the recording systems are ready for this, and that the owners of the data be aware that copies of the records will be requested for analysis. Such activities will be coordinated through the WECC Disturbance Monitoring Work Group (DMWG).

Previous versions of these tests are described in WECC documents such [1,2] and reports for tests performed from September 2005 through August 2006 [3]. Distinguishing features of the tests in 2005 and 2006 had a strong focus on Objective C, plus greatly improved instrumentation and software for achieving this objective. This test will again have a strong focus on Objective C. This time it will include an intermediate level probing signal that addresses frequencies in the range frequencies from 0.2 Hz to 1.0 Hz as illustrated by Figure 10. New experience will also be gained with reduced low level probing amplitudes in the range of $\pm$10 to $\pm$20 MW.

2. Operating Conditions Required For Tests

Operating Conditions for Test Series

- Power system operation normal, with no impediments to safe testing
- Pacific HVDC Intertie (**PDCI**) in bipolar operation with North to South flow
- PDCI power transfer above 800 MW and less than 2950 MW
- Langdon – Cranbrook 500 kV line in service.

3. Test Precautions and Termination Procedure

If at any time the Test Observers, security coordinators or system operators identify conditions under which the tests should not continue then the Test Director will suspend the test sequence until those conditions are no longer present.

Reasons for suspending, modifying, or terminating the test sequence include but are not limited to the following:

- System emergency exists within the WECC
- Interconnections operating outside normal limits
- Undamped or unacceptable levels of system oscillations
- Facility operator deems that facility is unsafe for test, or that the test procedure is interfering with proper operation of that facility
- Test procedure is conflicting with a peak in operator workload

3. Sequence of Test Events

The list below shows specific test events to be performed. Times for these test events are in Pacific Daylight (Advanced) Time (PDT).

The time and the duration of specific test events can be adjusted, during the test itself, to minimize interference with smooth operation of the power system. A description of each playback file is given on page 14.

Test Series A: Calibration Checks on PDCI Probing Signals

Step A0 [9:00] Celilo instrumentation check using +/-10MW waveform. Check proper function of PSG using Celilo/Sylmar DC metering.

Step A1 [9:10] Calibration check on MSF-20/6/17 for ±5 MW noise probing to determine HVDC pole response. Noise bandwidth will be 20 Hz. Adjust scaling of Probing Signal Generator (PSG) if needed.

Step A2 [9:15] Apply MSF-20/6/17 for ±5 MW noise probing to determine HVDC pole response. Expected duration is 5 minutes or less.

Step A3 [9:20] Calibration check on MSF-1/6/100 for ±10 MW noise probing of inter-area modes. Adjust PSG scaling if needed.

Step A4 [9:25] Apply MSF-1/6/100 for ±10 MW noise probing of inter-area modes. Expected duration is 10 minutes, but additional time may be needed for coordination of real-time observations at remote locations.

Step A5 [9:40] Apply PbfSM2 for single-mode probing ±125 MW. Waveform will be three cycles of a sine wave at 0.25 Hz.

Step A6 [9:42] Apply PbfSM3 for single-mode probing ±125 MW. Waveform will be three cycles of a sine wave at 0.70 Hz.

Step A7 [9:44] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

Test Series B: Noise Probing

Step B1 [10:10] Measurement of ambient noise conditions

Step B2 [10:30] Apply a ±20 MW MSF-1/6/100 for a duration of 12 periods (20 minutes).

Test Series C: Cross Validation of Probing Methods

Step C1 [13:10] Insertion B1 of the Chief Joseph Dynamic Brake

Step C2 [13:15] Insertion B2 of the Chief Joseph Dynamic Brake, five minutes after insertion B1

Step C3 [13:20] Apply a ±20 MW MSF-1/6/100 for a duration of 15 periods (25 minutes). Additional time may be needed if powerflow shifts or discrete control actions are noted during the test interval.

Step C4 [13:47] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

Step C5 [13:49] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

Test Series D: Noise Probing

Step D1 [14:10] Measurement of ambient noise conditions

Step D2 [14:11] Apply a ±10 MW MSF-1/6/100 for a duration of 21 periods (35 minutes).

Step D3 [14:47] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

Step D4 [14:49] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

Test Series E: Noise Probing

Step E1 [15:10] Measurement of ambient noise conditions

Step E2 [15:11] Apply a ±20 MW MSF-1/6/100R for a duration of 21 periods (35 minutes).

Step E3 [15:47] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

Step E4 [15:49] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

Test Series F: Noise Probing

Step F1 [16:10] Measurement of ambient noise conditions

Step F2 [16:11] Apply a ±15 MW MSF-1/6/100 for a duration of 21 periods (35 minutes).

Step F3 [16:47] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

Step F4 [16:49] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

Test Series G: Brake Application

Step G1 [17:10] Insertion B1 of the Chief Joseph Dynamic Brake.

Step G2 [17:15] Insertion B2 of the Chief Joseph Dynamic Brake, five minutes after insertion G1

Step G3 [17:20] Apply a ±20 MW MSF-1/6/100 for a duration of 15 periods (25 minutes).

Step G4 [17:47] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

Step G5 [17:49] Apply PbfSM5 ±125 MW intermediate level short-term probing wave.

5. Test Coordinator and Responsibilities

Test coordination will be as follows:

1. Jim Burns will schedule the tests through the BPA outage dispatcher.
2. Jim Burns (BPA technical staff) will post proposed test dates on the BPA Web page.
3. The day before each test, BPA will send a message on the WECC Net notifying of the tests.
4. If there are concerns about abnormal system conditions, BPA dispatcher should be contacted as early as possible to cancel a test. The test will be resumed the next hour after the system returns to normal.
5. The probing signal will be injected by an operator of Celilo converter station. The operator will clear with the BPA dispatcher before the signal injection.

A listing of contact persons and test observers with phone numbers and e-mail addresses is provided on page 13. A phone bridge will be available on the day of the test.

6. Measurement Requirements

WAMS data from these tests will be recorded automatically. However, it is necessary that the operators of the measurement facilities assure that the recording systems are ready for this, and that the owners of the data be aware that copies of the records will be requested for analysis.

Required measurements for Test Series

- Continuous PDC, PMU and PPSM recording is required at BPA locations for the period 0800 through 1800 PDT of the test day.
- Continuous PDC, PMU and PPSM recording is highly desirable at all other WECC locations for the period 0800 through 1800 PDT of the test day where this data is available.
- Continuous recording with the Celilo PPSM is required. It is desired that the recording rate be 960 sps, but 240 sps is acceptable. Data acquisition filters must be set appropriately. To limit file size, it is highly important that the point-on-wave ac signals (signals 16 through 39) not be recorded. It is desirable that a separate recorder be installed for this sometime in the future.

Required facilities for real-time analysis

A key objective in the proposed tests is to "Refine and validate methods that identify power system dynamics with minimal or no use of probing signals." Key real-time resources for this are PDC StreamReaders, located at key locations, plus the spectral analysis tool provided as an add-on for the PDC StreamReader. Other documents refer to this tool as Dynamic Signal Analyzer (**DSA**), and that terminology is used here. Equivalent functionalities can also be obtained from alternate toolsets such as RTDMS and the DOE ModeMeter.

It is essential that DSA analysis be immediately available to the Test Director throughout the test. StreamReaders with DSA are essential at Dittmer and highly desirable at Celilo and PNNL Richland. It is also suggested that California ISO and other organizations that have PDC StreamReaders or alternate toolsets use them to observe test results in their service areas.

7. Test Preparations

The Celilo Probing Signal Generator (PSG) will be furnished with a suitable menu of playback files. These playback files will be verified on site for MW scaling and other characteristics before their use in long term probing. BPA & PNNL will work together on PSG matters.

8. Illustrations of Applied Test Signals

The following figures are illustrative of the system response to signals that will be applied during this test. Additonal information on the test signals and system response is provided in [3] and in various other documents cited there.

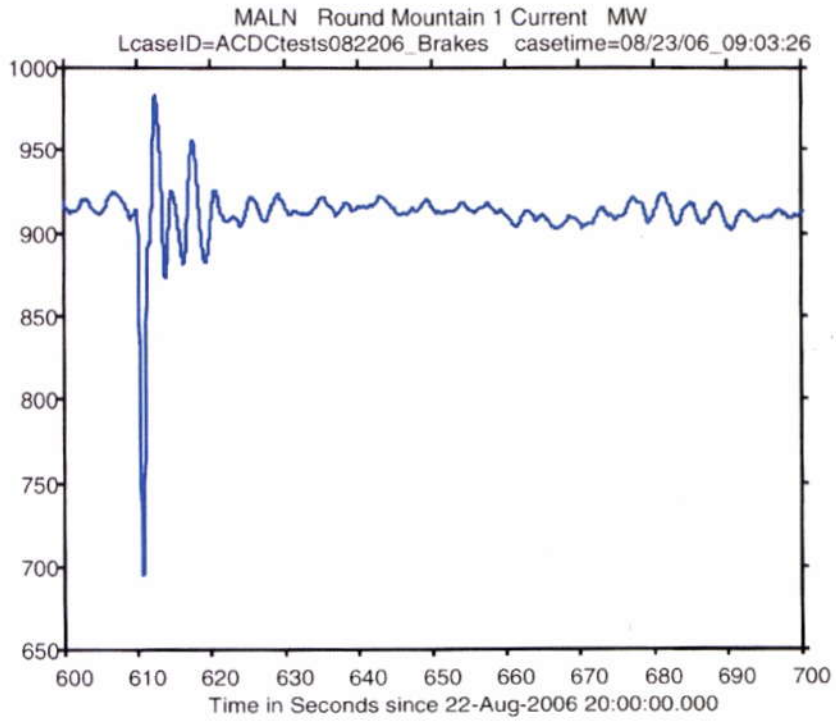

Figure 1. Malin-Round Mtn MW respionse to Chief Joseph Brake Application B1, 08/22/06