UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

North American Electric Reliability Corporation	**)** **)**	**Docket Nos. RM06-16-010** **RM06-16-011**

COMMENTS OF THE NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION FOLLOWING SEPTEMBER 23 FREQUENCY RESPONSE TECHNICAL CONFERENCE

Gerald W. Cauley
President and Chief Executive Officer
David N. Cook
Senior Vice President and General Counsel
North American Electric Reliability Corporation
116-390 Village Boulevard
Princeton, NJ 08540-5721
(609) 452-8060
(609) 452-9550 – facsimile
david.cook@nerc.net

Rebecca J. Michael
Assistant General Counsel
Holly A. Hawkins
Attorney
North American Electric Reliability Corporation
1120 G Street, N.W., Suite 990
Washington, D.C. 20005-3801
(202) 393-3998
(202) 393-3955 – facsimile
rebecca.michael@nerc.net
holly.hawkins@nerc.net

October 14, 2010

TABLE OF CONTENTS

Page

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

North American Electric Reliability Corporation	**)** **)**	**Docket Nos. RM06-16-010** **RM06-16-011**

COMMENTS OF THE
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION
FOLLOWING SEPTEMBER 23 FREQUENCY RESPONSE TECHNICAL CONFERENCE

I. INTRODUCTION

The North American Electric Reliability Corporation ("NERC") hereby submits these comments following the September 23 Frequency Response Technical Conference held in this docket. NERC will also file, by October 25, 2010, its proposed timeline for development of a Reliability Standard addressing frequency response, as directed by the Commission's May 13, 2010 Order.[1]

[1] *Order Granting Rehearing for Further Consideration and Scheduling Technical Conference,* 131 FERC ¶61,136 (May 13, 2010).

II. NOTICES AND COMMUNICATIONS

Notices and communications with respect to this filing may be addressed to:

Gerald W. Cauley
President and Chief Executive Officer
David N. Cook*
Senior Vice President and
General Counsel
North American Electric Reliability
Corporation
116-390 Village Boulevard
Princeton, NJ 08540-5721
(609) 452-8060
(609) 452-9550 – facsimile
david.cook@nerc.net

Rebecca J. Michael*
Assistant General Counsel
Holly A. Hawkins
Attorney*
North American Electric Reliability
Corporation
1120 G Street, N.W., Suite 990
Washington, D.C. 20005-3801
(202) 393-3998
(202) 393-3955 – facsimile
rebecca.michael@nerc.net
holly.hawkins@nerc.net

* Persons to be included on FERC's service list are indicated with an asterisk. NERC requests waiver of FERC's rules and regulations to permit the inclusion of more than two people on the service list.

III. DISCUSSION

NERC RECOMMENDATIONS IN RESPONSE TO FREQUENCY RESPONSE TECHNICAL CONFERENCE

Frequency response of the interconnected North American electric systems has shown a significant decline for several years. The reasons for the decline are numerous, including:

- A trend toward larger governor deadband settings, exceeding the historical typical setting of ±36 millihertz (mHz);
- Use of steam turbine sliding pressure controls;
- Loading units to 100 percent of capacity leaving no "headroom" for response to losses of generation;
- Blocked governor response;
- Once-through boilers;
- Gas Turbine inverse response;

- Withdrawal of primary frequency response of generators by MW setpoints, resulting in limited time of response; and
- Changes in the frequency response characteristics of the load.

These changes have been evolving for some time and are not the direct result of the emergence of renewable resources such as wind and solar. However, the effects of all resources and loads need to be fully understood.

The analysis of frequency response must be broken down into the time periods in which the various components of the response act. Understanding which of those control components can and should be modified to influence the overall response is crucial to coming up with cohesive and effective solutions. Figure 1 below shows a classical frequency excursion response and its components.

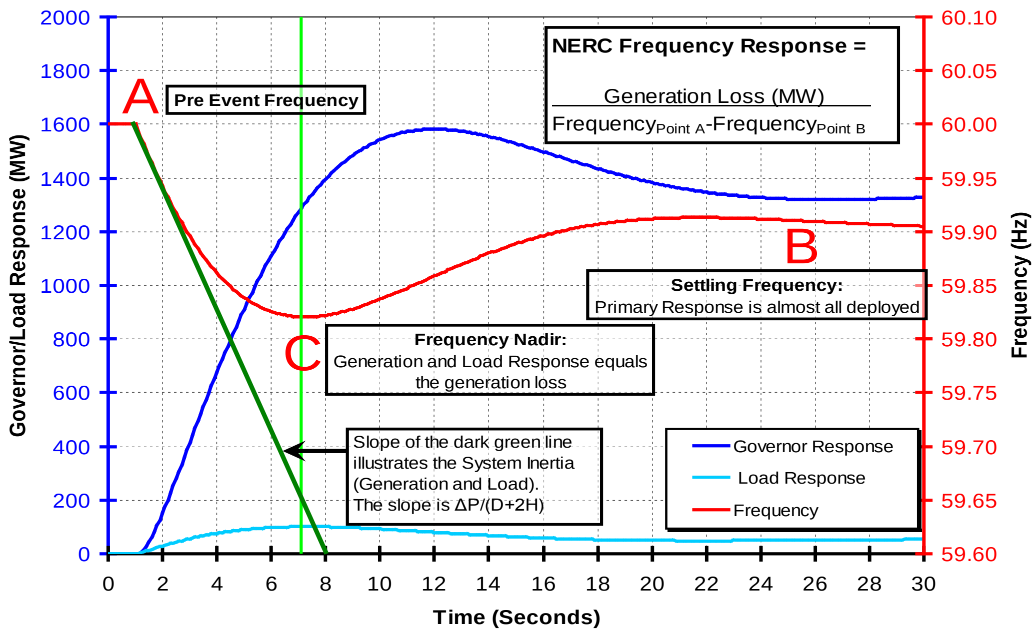

Figure 1 – Frequency Response Basics[2]

---

[2] Source: FERC Office of Electric Reliability available at: http://www.ferc.gov/EventCalendar/Files/20100923101022-Complete%20list%20of%20all%20slides.pdf

From the pre-event frequency (Point A), the size of the resource loss and the inertia of the system determine the slope of the frequency decline. The combination of primary response of generators and load response arrest the decline at the frequency nadir (the lowest point, Point C) when their magnitude equals the generation lost. Frequency then rebounds to the settling frequency (Point B) as the primary response becomes fully deployed.

NERC has historically measured frequency response as the response between Points A and B. Figure 2 below shows the trend of decline in that frequency response for the Eastern Interconnection from 1994 through 2009. If this trend is not corrected, frequency response will eventually become too low to maintain bulk power system reliability.

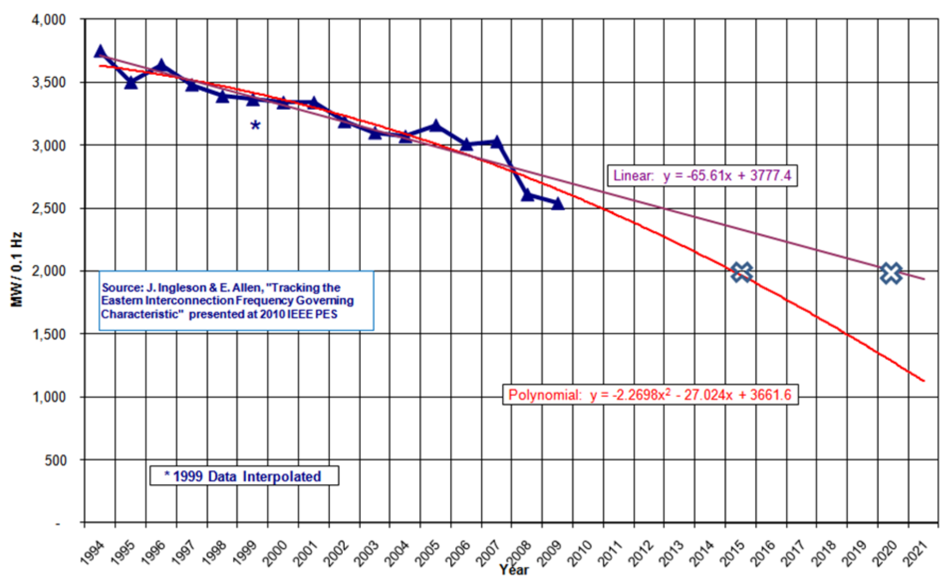

Figure 2 – Eastern Interconnection Mean Primary Frequency Response –1994 through 2009

If the decline in the Eastern Interconnection frequency response is extrapolated, the conservative linear projection falls below 2,000 MW/0.1 Hz by 2020. The projection reaches that same level in 2015, if a more pessimistic regression is applied.

Although the decline in frequency response in Figure 2 is disconcerting, that trend refers to the response to the settling frequency, the point B in Figure 1. More significant threats to reliability come from (1) the frequency nadir, point C, reached during frequency excursions; (2) the time it takes for the primary frequency response of generators and loads to arrest the drop in frequency; and (3) the time it takes for the frequency to rebound to point B. The threat to reliability primarily comes from the possibility of credible contingencies encroaching on the trigger points for the first steps of under-frequency load shedding (UFLS), or trigger undesirable reactions from any potential frequency-sensitivities (potential for tripping) frequency sensitive loads or electronically-coupled renewable resources. A related threat comes from sustained low frequency or withdrawal of primary frequency response. Both leave the system vulnerable to potential system collapse should an additional large loss of generation occur at the time when the frequency is already low and the primary frequency response is unavailable because it has already been fully deployed in reaction to the initial event.

Several phenomenon and control parameters are influential in controlling those reliability threats:

- The steepness of the frequency drop is dependent on the amount of generation loss and the inertia of the system; the lower the system inertia, the steeper the slope for the same loss of generation;

- The steeper the slope of the decline, the more faster-acting primary frequency response is needed to arrest the decline before it encroaches on the Under Frequency Load Shedding ("UFLS") triggers. This points to two controllable parameters: amount of frequency-responsive generation and loads, and the speed of that response;

- The longer the frequency stays depressed near the frequency nadir at point C, the higher the chance of triggering the time delays on UFLS systems. This requires that there be sufficient frequency-responsive resources to create a rebound and initiate the frequency recovery.

a. NERC's Frequency Response Initiative Work Plan and Next Steps

The ongoing decline in frequency response poses a complex and significant challenge for maintaining bulk power system reliability. To comprehensively and effectively address the issues related to frequency response, NERC launched the Frequency Response Initiative in February 2010 that includes coordination of multiple efforts underway in standards development and performance analysis, and performing in-depth interconnection-wide frequency response analysis to achieve a better understanding of the factors influencing frequency performance across North America.

The main objectives of the Frequency Response Initiative include:

- Coordinating all NERC standards development and performance analysis activities related to frequency response and control;
- Developing metrics and benchmarks to improve frequency response performance tracking;
- Collecting and providing more granular data on and technical analyses of frequency-driven bulk power system events, including root cause analyses;
- Identifying specific frequency-related reliability factors;
- Identifying root causes of changes in frequency response;
- Identifying practices and methods to address root causes;
- Determining what performance-based frequency response standards are warranted;
- Consider the potential effects from the integration of new generation technologies (such as wind, solar, and significant nuclear expansion), changes to load frequency response characteristics,; and
- Share lessons learned with industry via outreach, alerts, and webinars.

The following is an outline of the technical tasks associated with NERC's Frequency Response Initiative. A number of these tasks are underway, while others are in the scoping phase. The analyses of Frequency Response and Control can be generally divided into the near-team, mid-term, and longer-term tasks:

Near-Term Tasks

1. Issuance of a Recommendation and a survey pursuant to Section 810 of NERC's Rules of Procedure to collect data and information from Generator Owners, Generator Operators, and Balancing Authorities to evaluate how frequency response should be addressed.

Two Recommendations were issued pursuant to Rule 810 of NERC's Rules of Procedure regarding the decline in frequency response. The reporting associated with those Recommendations will help to calibrate the status of industry generator governor settings and Balancing Authority frequency response performance.

A Governor Response Recommendation and related survey was issued to Generator Owners (GOs) and Generator Operators (GOPs) under section 810 of the NERC Rules of Procedure on September 9, 2010. The survey requested information and operational settings for generator governors for all units 20 MVA and above or plants that aggregate to a total of 75 MVA or greater net rating at the point of interconnection (*i.e.*, wind plant, PV plant).

The survey requested detailed information on governors and their settings for each unit. The data collection is intended to serve two purposes: (1) to initiate a review by Generator Owners and Operators of the state and control settings of their governors in relation to the 2004 Guidelines[3], and (2) to create a benchmark of governor data and settings for comparison to governor models in transient stability simulation models.

The information provided in the Governor Response Survey will be used to benchmark unit governors on units across North America. The data will also be cross-checked against the governor models in the dynamics simulation models used to analyze interconnection system dynamics. Any discrepancies will be resolved with the generator owners' improvement of transient simulation models of generator primary frequency response. This activity coincides with the NERC Modeling Improvements Initiative, based on recommendation for improving

[3] NERC Operating Policy 1 - Generation Control and Performance, section C, Frequency Response and Bias

modeling from the 2003 blackout. Responses to the survey are due by December 9, 2010 (90 day response). A subsequent report to FERC will be issued within 30 days of that date, in accordance with Section 810 of the NERC Rules of Procedure.

Additionally, a Frequency Response Survey, issued as an Alert Recommendation, was sent to Balancing Authorities on September 14, 2010, calling for Balancing Authorities to document their frequency response for events in late-2008 and 2009.

The information submitted in response to this Alert will provide a benchmark of Balancing Authority Frequency Response from selected frequency deviation events, assisting the Frequency Response Standard (FRS) drafting team to make informed decisions while streamlining the data collection for the proposed standard. Responses to the Alert are due by October 29, 2010 (45 day response). A subsequent report to FERC will be issued within 30 days of that date.

2. Develop a clear common set of clear terminology for use by NERC, FERC, and the industry.

Having a common set of mutually-understood terminology is essential for the industry to be able to discuss frequency response technical issues. Therefore, the NERC Resources Subcommittee, the Frequency Working Group, and the standards drafting teams working on frequency-related issues developed a set of consistent terms. That list was circulated for review by the NERC Planning and Operating Committees in September 2010.

The FERC Office of Electric Reliability has also developed an internal set of terms related to frequency response. Work is underway to merge the two lists. This task should be completed within two months.

3. Analyze current and historical Primary and Secondary Control Response performance to determine what factors influence that performance.

A Control Factor Task Team is being formed by NERC staff and members of the Resources Subcommittee, Frequency Working Group, and the Frequency Response Standard Drafting Teams to review historical primary and secondary control frequency response performance and the generator governor survey responses focused on identifying the factors that influence that performance. The task team will also analyze potential ways to improve performance by addressing those factors wherever possible. Some of the parameters included in the analyses are: existing primary control parameters (governor behavior), influence of the amount and response speed of frequency responsive resources, plant-level controls influence, and ACE equation influences of bias levels. This task is expected to take six months to complete.

4. Develop appropriate metrics for tracking frequency performance on each interconnection to monitor trends.

The Resources Subcommittee and the Frequency Response Standard Drafting Team are in the process of developing a set of interconnection-wide frequency response performance metrics to monitor trends. These metrics and analyses will be incorporated in the automated frequency event detection and data collection systems described below. This work should be completed by the end of 2010.

5. Develop automated method for identifying frequency deviation events to be used for Balancing Authorities to measure Primary Control Response.

NERC staff and the Resources Subcommittee are evaluating a software tool and database developed by the Consortium for Electric Reliability Technology Solutions (CERTS) to be adapted to detect and collect data for frequency deviation events. Modifications to automate the event detection triggers and initiate archiving of appropriate data parameters about those specific events will enable automated analysis of interconnection level frequency response performance and development of a uniform set of events for Balancing Authority performance analysis. The set of events would be subject to review and approval for use by NERC's Resources Subcommittee.

Initial program modifications based on available SCADA scan-rate data should be achievable in three to six months. Future enhancements could include synchro-phasor-based event detection and triangulation.

6. Develop sustainable methods for automatically collecting, trending, and analyzing various elements of frequency response and control for frequency deviation events.

NERC staff, the Resources Subcommittee, and the Frequency Response Standard Drafting Team are evaluating additional software tool modifications to enable synchro-phasor measurements to be used to determine the characteristics and trends of interconnection frequency response performance through automated determination of the pre-event frequency (point A), the frequency nadir (point C), and the settling frequency (point B). This functionality would be coupled with the event detection algorithms, and be subject to the Resources Subcommittee oversight.

The trending work will be coordinated with the NERC Reliability Metrics Working Group. Program modifications would be specified within six months with completion of the modifications taking another three to six months.

Mid-Term Tasks

7. Explore and analyze what are appropriate frequency response and control performance requirements to maintain system reliability.

This mid-term task will identify the control parameters that are available to influence frequency response performance during each phase of the overall response to a frequency perturbation: system inertia, frequency responsive reserve levels, control parameters of generator governors, secondary controls at the plant and Balancing Authority level, potential market influence, and controls afforded by new electronically-coupled resources and loads. A significant portion of this analysis will necessarily focus on the use of load controls to provide primary frequency response, which may require deeper research into the characteristics of new devices as a longer-term task.

8. Determine an appropriate minimum bias setting for use in AGC systems as part of an overall Frequency Response and Control strategy.

This task calls for the analysis of the interaction of secondary response (AGC) with the primary response within Balancing Authorities. This analysis would examine the theoretical and practical (through a field trial) range of bias settings that should be used in ACE equations to optimize and sustain frequency response performance. Ranges of primary response performance can help determine appropriate bias values. The analysis should include technical evaluation of the current practice of using a 1 percent of load minimum bias setting. This task should take about nine months to complete.

9. Improve transient dynamic models of Primary Control Response for generators and other devices.

The first phase of this task is to analyze the results of the survey information of operational settings for generator governors, and compare them to the governor models contained in the dynamics cases used for transient stability analysis. This review is expected to take six to nine months.

The second phase of this task is to create a sustainable feedback loop to the Generator Owners and Generator Operators, Regional Entities, Planning Authorities, and Transmission Operators to detect and correct any errors in transient governor models and parameters. This feedback mechanism was called for in the detailed recommendations from the 2003 blackout analysis (recommendation 14). These two phases should be run in parallel.

Longer-Term Tasks

10. Develop and implement mid-term dynamic models of Primary Control Response of generators and other devices.

This long-term extension of the transient dynamics model work beyond the 20-second complements NERC's mid-term dynamics work of the Modeling Improvements Initiative. Research involving the industry, generator turbine control manufacturers, and academia will be necessary to develop the modeling and analysis techniques of the longer-term behavior of the electric systems in the seconds-to-minutes timeframe. The control actions of modern generator, turbine, boiler, and system controls and their interactions with the existing automated and manual bulk power system controls and protection systems must be understood in order to predict their behavior. The importance of such interaction was highlighted by the interaction of boiler and turbine controls with system performance beyond the timeframe normally analyzed for transient stability in a number of system disturbances since 2003.

11. Analyze current Inertial Response and determine what factors influence response performance.

High-speed (up to 30 samples per second) measurements using synchro-phasors (PMUs) should be consistently used to analyze and trend the inertial performance of the interconnections and to determine the depth of the frequency nadir (point C) for frequency events. Correlation analysis to system load and generator inertia should be analyzed for all events determined to be examined for frequency response performance. This work will be developed as a longer-term task associated with the detection, triangulation, and data collection tasks described earlier. Work is being initialized with the national laboratories using data from the Western and Eastern Interconnections.

12. Examine Primary Control Frequency Response characteristics of electronically-coupled resources and "smart grid" loads.

A key element to predicting system reliability in the near future will be to determine how the electronic coupling controls of renewable resources and "smart grid' loads such as electric vehicle chargers, potentially could be used to provide primary frequency response.

Research on the characteristics of devices such as variable speed drive motors is already underway. Similar analysis of other new load characteristics must also be conducted.

Two very important determinations must be made: 1) whether there any common-mode failure modes lurking in the transient, post-transient, and mid-term stability characteristics when subjected to combinations of voltage and frequency variations that are present during system disturbances, and 2) whether there are control parameters in the electronic couplings of the new loads and resources that can be used to provide a favorable response to those perturbations. Use of that knowledge can then be used to model and predict system behavior.

13. Explore how displacement of inertial generation with electronically-coupled resources might influence Inertial Response.

This long-term task is expected to analyze the sensitivity of system dynamics to changes in inertial response and synchronizing torque caused by the displacement of inertial generation with non-inertial, electronically-coupled resources. This analysis has a predecessor of determining the characteristics of electronically-coupled resources and loads in the previous task. Some electronically-coupled resources have the capability to transfer or mimic inertial response, and this capability must be well understood for this evaluation.

The analysis will focus on how the new blend of resources and loads perform relative to the attenuation of oscillatory impulses and inter-area oscillations, and whether sufficient dynamic cohesion of the geographically and electrically wide-spread bulk power system can be maintained with lower inertia values. A natural follow-on to that analysis should address how the application of new fast-acting primary response potentially afforded by new technologies in loads and resources, can be used to effectively counteract lower local and system inertia during frequency perturbations.

Respectfully submitted,

Holly A. Hawkins

Gerald W. Cauley
President and Chief Executive Officer
David N. Cook
Senior Vice President and
General Counsel
North American Electric Reliability
Corporation
116-390 Village Boulevard
Princeton, NJ 08540-5721
(609) 452-8060
(609) 452-9550 – facsimile
david.cook@nerc.net

Rebecca J. Michael
Assistant General Counsel
Holly A. Hawkins
Attorney
North American Electric Reliability
Corporation
1120 G Street, N.W., Suite 990
Washington, D.C. 20005-3801
(202) 393-3998
(202) 393-3955 – facsimile
rebecca.michael@nerc.net
holly.hawkins@nerc.net

CERTIFICATE OF SERVICE

I hereby certify that I have served a copy of the foregoing document upon all parties listed on the official service list compiled by the Secretary in this proceeding.

Dated at Washington, D.C. this 14th day of October, 2010.

/s/ Holly A. Hawkins
Holly A. Hawkins
Attorney for North American Electric Reliability Corporation