UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

REPORT ON FREQUENCY RESPONSE METRICS TO ASSESS REQUIREMENTS FOR RELIABLE INTEGRATION OF VARIABLE RENEWABLE GENERATION	**)** **)** **)** **)**	**Docket No. AD11-8-000**

COMMENTS OF THE NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION ON REPORT "USE OF FREQUENCY RESPONSE METRICS TO ASSESS THE PLANNING AND OPERATING REQUIREMENTS FOR RELIABLE INTEGRATION OF VARIABLE RENEWABLE GENERATION" AND FIVE SUPPORTING PAPERS

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I. INTRODUCTION

The North American Electric Reliability Corporation ("NERC")[1] hereby provides these comments following the January 20, 2011 release of the FERC-sponsored report prepared by the Lawrence Berkeley National Laboratory on the *Use of Frequency Response Metrics to Assess the Planning and Operating Requirements for Reliable Integration of Variable Renewable Generation* and its five supporting papers.[2] NERC is grateful for the opportunity to provide comments on the issues discussed in the Report.

II. NOTICES AND COMMUNICATIONS

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

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[1] The Federal Energy Regulatory Commission ("FERC" or "Commission") certified NERC as the electric reliability organization ("ERO") in its order issued on July 20, 2006 in Docket No. RR06-1-000. *North American Electric Reliability Corporation*, "Order Certifying North American Electric Reliability Corporation as the Electric Reliability Organization and Ordering Compliance Filing," 116 FERC ¶ 61,062 (July 20, 2006).

[2] Ernest Orlando Lawrence Berkeley National Laboratory, *Use of Frequency Response Metrics to Assess the Planning and Operating Requirements for Reliable Integration of Variable Renewable Generation*, LBNL-4142-E, (December 2010). The Report was authored by: Joseph H. Eto, John Undrill, Peter Mackin, Ron Daschmans, Ben Williams, Brian Haney, Randall Hunt, Jeff Ellis, Howard Illian, Carlos Martinez, Mark O'Malley, Katie Coughlin, and Kristina Hamachi LaCommare.

III. DISCUSSION

On January 20, 2011, FERC posted the Report and its five supporting papers, *Analysis of Wind Power and Load Data at Multiple Time Scales*; *Dynamic Simulation Studies of the Frequency Response of the Three U.S. Interconnections with Increased Wind Generation*; *Frequency Control Performance Measurement and Requirements*; *Power and Frequency Control as it Relates to Wind-Powered Generation*; and *Review of the Recent Frequency Performance of the Eastern, Western and ERCOT Interconnections* (collectively, "the Report"). The Report was prepared by the Lawrence Berkeley National Laboratory ("LBNL").

NERC has a reviewed the Report and has identified a number of areas to which NERC responds below. NERC sought input from the NERC Planning and Operating Committees and the Integration of Variable Resources Task Force ("IVGTF") regarding these areas, and is also including discussion on a number of other areas that merit consideration. NERC's comments are included below.

1. NERC commends the study for not limiting analysis of the problems of frequency response to just renewable resources.

NERC applauds FERC's efforts to understand frequency response impacts and causes. NERC appreciates that FERC funded this Report as it provides a material contribution to the ongoing efforts of NERC and the industry to assure that the bulk power network can be operated reliably and efficiently in an era of unprecedented change in generation resource mix, increased use of utility scale electricity storage and innovative use of energy efficiency, conservation and demand response. The Report also provides an excellent summary of the frequency response situation.

Further, the Report provides a good synopsis of the history of frequency response performance in North America and is an important contribution toward identifying clear actions

to address frequency response in the future. It also provides good technical background and training material relative to several aspects of frequency response performance of resources, loads, and the propagation of frequency events across the interconnection. These set the stage for further comprehensive analysis with a common knowledge base for further, ongoing analysis of the frequency response issue.

Additionally, it was appropriate to expand the scope of the Report to take a broader look at all of the causes of and problems associated with frequency response decline, instead of focusing exclusively on variable renewable resources. NERC has spent nearly a decade examining the issue of frequency response and, as explained in NERC's comments filed with the Commission following the September 2010 FERC technical conference on frequency response,[3] the data indicates that changes in the way conventional power plants are being operated is the primary factor responsible for the currently experienced frequency response decline, as well as changes in the makeup of electricity demand, and not the addition of variable renewable resources.

That said, the Report does not identify an immediate threat to reliability. Nonetheless, there is a need to adequately investigate the optimal frequency response targets in North America through appropriate research, peer review, and field validation. FERC should now allow NERC the time to work with the industry experts to fully identify the causal factors of the frequency decay and develop appropriate solutions and actions. Under the leadership of NERC, the Report is already under detailed review by transmission operators, providers, and other market participants and stakeholders to chart out a future course of action. NERC and industry experts

[3] *See, North American Electric Reliability Corporation*, "Comments of the North American Electrical Reliability Corporation Following September 23 Frequency Response Technical Conference," Docket Nos. RM06-16-010 and RM06-16-011 (October 14, 2010).

are well positioned to take the appropriate next steps, and due regard should be provided to NERC to address this emerging concern.

In addition, some of the analysis completed by LBNL will enable NERC to modify and streamline some of the tasks proposed within its frequency response activities. The key related ongoing tasks that NERC is pursuing as part of its frequency response activities are:

- Analyze current and historical primary and secondary control response performance and identify the factors that influence performance.
- Develop appropriate metrics for tracking frequency performance on each interconnection to monitor trends and performance. Develop sustainable automated methods for identifying, collecting, trending, and analyzing frequency deviation events for use by balancing authorities to measure primary control response.
- Explore and analyze what are appropriate frequency response and control performance requirements to maintain system reliability. Determine appropriate minimum bias settings for use in automatic generation control systems.
- Improve transient dynamic models of primary control response for generators, load and other devices. Develop load and "generator" models (research required) and devices to properly analyze influence on system behavior in transient, post-transient, and mid-term stability.
- Explore how displacement of inertial generation with electronically-coupled resources might influence inertial response. Further, examine primary control frequency response characteristics of electronically-coupled resources and "smart grid" loads.

The inertial response performance factors and displacement of inertial generation with electronically-coupled resources analysis presented in the Report partially address two of the longer-term planned work tasks. Further, analysis addressed within the Report enables NERC to focus more on the development of an integration strategy for new generation technologies (such as wind, solar, storage, and significant nuclear expansion), and the need to develop an integration strategy for demand-side frequency responsive capabilities.

The conclusions of the Report are based on the projected integration of renewables through 2012, which covers a very short time frame. The basic conclusion is that, with careful

planning, conventional frequency responsive resources can cope with the planned level of renewables. Additional detailed and comprehensive analysis will be required on an ongoing basis as industry experiences and addresses the unprecedented change in resource mix beyond 2012. The development of a comprehensive plan for maintaining and providing for frequency response will be required throughout North America to ensure the continued, reliable operation of the bulk power system.

NERC will be pursuing this strategy through its Frequency Response Initiative, its data collection, analysis, trend evaluation, and input into its reliability standard activities, along with and development of interconnection recommendations made by NERC's IVGTF.

2. NERC is concerned that the report characterizes the setpoints of the first stages of Under-Frequency Load Shedding ("UFLS") as the only consideration for interconnection frequency response performance.

Throughout the Report, the setpoints of the first stages of UFLS are characterized as the primary consideration for interconnection-level frequency response performance requirements. NERC firmly believes that avoiding the first stage of UFLS is necessary, but does not believe it alone is sufficient in determining the frequency performance requirements of large interconnections. Rather, NERC believes that consideration must also be given to minimum levels of frequency response during islanded operation conditions. Under such operating conditions, a minimum level of frequency response is required within the islands to provide for sustainable operations in coordination with UFLS programs.

Also, consideration should be given to the impact from the performance characteristics of new load types (*i.e.*, LED lighting, and car chargers) as well as the operational characteristics of electronically-coupled and conventional generating resources during system disturbances, especially due to frequency perturbations (*i.e.*, potential for common-mode tripping). This will

ensure future systems are well prepared for changes in not only supply-side resources, but also the characteristics of the demand it will serve.

3. NERC agrees that the dynamic model simulation of frequency response must be improved to study the adequacy of frequency response.

The Report points out the modeling needs that must be met for each of the interconnections' dynamic simulation models to replicate actual frequency response of recorded system disturbances. Some of the issues lie in the governor settings in the off-the-shelf dynamics cases, which may not be appropriate for frequency analysis. To address this and other considerations, NERC is working with the Regional Entities to improve the dynamic models and development processes that are currently used to build models in North America. NERC is also comparing generator governor characteristics and setting models on a unit-by-unit basis against governor information provided in a recent governor survey conducted in the fall of 2010. That comparison will confirm that the dynamic models reflect the installed governors. Future analysis of interconnection-wide frequency response using dynamic simulations should be carefully planned and the models vetted and reviewed to ensure that the frequency responsive characteristics of the load are properly represented.

4. The purpose of UFLS is mischaracterized as a way to prevent damage to generators.

The Report at page 11 states:

> Under-frequency load shedding is a blunt and drastic form of emergency frequency control.[] It is intended to prevent damage to generators during the extreme imbalances in frequency that result when the integrity of the interconnected power system has been so severely compromised that portions of the system are operating as electrical "islands" distinct from one another.[]

The purpose of UFLS is not to prevent damage to generators. Under-frequency and over-frequency relays on the generators are meant to protect them from conditions that might damage them. While UFLS must be coordinated with the capability of generating units, the purpose of

UFLS is to balance load and generation to stabilize frequency and prevent collapse of a system or portions thereof.

The UFLS definition in the glossary of the Report correctly states the purpose of UFLS.

Definition of UFLS from the Report Glossary at page 100:

> Under-frequency load shedding:[4] A safety net designed to operate in order to preserve the generation in a portion of a region that has experienced major generation loss by shedding non-interruptible or firm load. The conditions assume that the region is not interconnected with the rest of the interconnection and that the generation will not trip by limiting the magnitude and time of off nominal frequency associated with the event. It is not intended to operate under even extreme design conditions.

The second sentence from page 11 would be more accurate if modified to:

"*It is intended to rebalance the load and generation in the extreme circumstances that result when the integrity of the interconnected power system has been so severely compromised that portions of the system are operating as electrical "islands" distinct from one another.*"

5. The Report Includes an Inaccurate Example to Support the Unintended Consequences of UFLS.

The Report at page 12 provides:

> Under-frequency load shedding can also have unintended consequences. For example, if the amount of load dropped by under-frequency load shedding is greater than the amount of generation that was lost, frequency will quickly rise and exceed the scheduled value. When this happens, other generators may disconnect themselves either automatically to protect themselves or for other reasons because frequency is now too high. Frequency will then start to decline again and an even larger blackout may ensue.

To support this assertion, the Report references a Text Box on page 13, which implies that the cause of the collapse of the island formed in the western portion of New York during the August 2003 event was due to generation tripping on overfrequency resulting from over-shedding of load. However, the electric islands that occurred on August 14, 2003 did not experience the

[4] Source: EPRI Power Systems Dynamics Tutorial. EPRI, Palo Alto, CA: 2009. 1016042

sequence described in the paragraph. The discussion in the text box appears to support the incorrect notion that the over-frequency condition in the western portion of New York occurred due to over-shedding of load by UFLS. In fact, the generation tripped as a result of high frequency caused by a generation surplus that existed within the island as it was formed; there was simply more generation than load in the island.

Accordingly, the first sentence of the language from page 12 of the Report would be more accurate if modified to *"Under-frequency load shedding can also have unintended consequences if it is not properly coordinated with adequate frequency response."*

IV. CONCLUSION

NERC appreciates the Commission's consideration of these comments.

Respectfully submitted,

/s/ Holly A. Hawkins

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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 6th day of May, 2011.

/s/ Holly A. Hawkins
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