UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Order Setting Deadline for Compliance	**)**	**Docket No. RM06-16-010**

REQUEST OF THE NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION FOR CLARIFICATION AND REHEARING OF THE ORDER SETTING DEADLINE FOR COMPLIANCE

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I. INTRODUCTION

Pursuant to Rule 713[1] of the Federal Energy Regulatory Commission's ("FERC" or the "Commission") Rules of Practice and Procedure, 18 C.F.R. § 385.713, the North American Electric Reliability Corporation ("NERC") hereby requests clarification and rehearing of the Commission's March 18, 2010 Order Setting Deadline for Compliance ("March 18 BAL-003 Order").[2] The Commission's March 18 BAL-003 Order directed NERC to submit a modification to the BAL-003-0 Reliability Standard that is responsive to the Commission's directives in Order No. 693[3] and to modify the BAL-003-0 standard within six months from the date of the March 18 BAL-003 Order. The Commission's directives to NERC on the BAL-003-0 standard include: (1) determining the appropriate periodicity of frequency response surveys necessary to ensure that Requirement R2 and other requirements of the Reliability Standard are being met; and (2) developing a modification to BAL-003-0 that defines the necessary amount of frequency response needed for reliable operation for each Balancing Authority with methods of obtaining and measuring that the frequency response is achieved.[4]

By this filing, NERC requests clarification and rehearing with respect to two key elements of the March 18 BAL-003 Order.

II. STATEMENT OF ISSUES FOR REHEARING

Pursuant to 18 C.F.R. § 385.713, NERC seeks clarification and rehearing on two issues in Paragraphs 13 and 18 of the March 18 BAL-003-0 Order, in which FERC directed the following:

> P13: Further, in Order No. 693, the Commission concluded:

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[1] *See* 18 C.F.R. § 385.713 (2010).
[2] *Order Setting Deadline for Compliance*, 130 FERC ¶ 61,218 (March 18, 2010).
[3] *See Mandatory Reliability Standards for the Bulk-Power System*, 18 C.F.R. pt 40, Docket No. RM06-16-000 at P 375 (March 16, 2007) ("Order No. 693").
[4] *See* March 18 BAL-003-0 Order at P 1 and Order No. 693 at P 375.

> We understand that the present Reliability Standard sets the required frequency response of the balancing authorities to be approximately one percent or greater by requiring that the frequency bias shall not be less than one percent and that the frequency bias be as close as practical to, or greater than, the actual frequency response.

> P18: Accordingly, to assure that NERC proceeds expeditiously, the Commission is setting a compliance deadline of six months from the date of issuance of this order for the development of modifications to Reliability Standard BAL-003-0 that comply with the Commission's directives as set forth in Order No. 693 to define the appropriate periodicity of frequency response surveys necessary to ensure that Requirement R2 and other requirements of the Reliability Standard are being met and the necessary amount of frequency response needed for reliable operation.

Specifically, NERC is seeking rehearing on:

> Issue 1: NERC seeks rehearing of the Commission's technical error in Paragraph 13 of the March 18 BAL-003 Order that the BAL-003-0 Reliability Standard sets the frequency response of Balancing Authorities to be approximately one percent of peak load of generation or greater. *See, e.g.,* 16 U.S.C. § 824o(d)(2)(2005); *see also,* 5 U.S.C. § 706(2)(A)(2005); *see also, Motor Vehicle Mfrs.,* 463 U.S. 29, 43 (1983); *Greater Boston Television Corp. v. FCC*, 444 F.2d 841, 852 (D.C. Cir. 1970).

> Issue 2: NERC seeks clarification or rehearing on the Commission's requirement in Paragraph 18 of the March 18 BAL-003 Order that NERC determine within a six month-deadline the necessary amount of frequency response needed for reliable operation. *See, e.g.,* 16 U.S.C. § 824o(d)(2)(2005); *see also,* 5 U.S.C. § 706(2)(A)(2005); *see also*, *Chevron, U.S.A., Inc. v. Natural Res. Def. Council, Inc.*, 467 U.S. 837, 843 (1984).

III. DISCUSSION OF ISSUES ADDRESSED BY THE REQUEST FOR CLARIFICATION AND REHEARING

The March 18 BAL-003-0 Order sets a deadline for NERC to comply with the directives on the BAL-003-0 Reliability Standard approved by FERC in Order No. 693 within six months and directs NERC to define the appropriate amount of frequency response needed for reliable operation. Although FERC acknowledged that it did not set a deadline in Order No. 693 for submitting modifications to the BAL-003-0 standard, it noted that almost three years have passed since the issuance of the directives. NERC included actions in response to the Order No. 693 directives as part of its ongoing efforts to upgrade the BAL-003-0 Reliability Standard, which are described in NERC's annual standards development plan filed with FERC each year, and for which project activities are underway. However, FERC has now directed NERC to submit modifications to BAL-003-0 that are responsive to FERC's directives from Order No. 693 within six months from the date of issuance of the March 18 BAL-003 Order.

NERC submits in this clarification and rehearing request that six months to comply with FERC's Order No. 693 directives does not provide enough time to conduct the necessary technical analysis relating to frequency response that must be considered before NERC can determine an appropriate frequency response requirement necessary for bulk power system reliability. However, NERC recognizes that there is a need to fully address frequency performance of generation and loads and their respective impact on frequency response across North America. In this filing, NERC is proposing a time schedule to address what needs to be done on frequency response and is providing an explanation of the Frequency Response Initiative that was developed specifically to respond to these issues.

NERC recognizes that, consistent with the Commission's concerns, immediate actions aimed to arrest the decline in frequency response in the Eastern Interconnection are necessary. Therefore, NERC's Frequency Response Initiative provides for both short-term actions to arrest the decline in frequency response and longer-term analyses to determine an appropriate amount of frequency response necessary for the reliable operation of the Interconnections and the various Balancing Authorities. Frequency performance expectation is an Interconnection-wide phenomenon that must be evaluated on an Interconnection-wide basis before an individual Balancing Authority frequency response can be established. Therefore, NERC believes it will be unable to comply with all of FERC's directives from Order No. 693 on the BAL-003 Reliability Standard within the six-month compliance deadline with the sufficiently rigorous engineering analysis necessary to determine the frequency response requirement needed for each interconnection that does not also place a significant and unnecessary cost burden for over-installing frequency responsive controls systems.

Additionally, NERC submits that there is a technical error in the March 18 BAL-003-0 Order in which FERC noted that in Order No. 693 the BAL-003-0 Reliability Standard sets the frequency response of Balancing Authorities to be approximately one percent of peak load or generation or greater.[5] In fact, the BAL-003-0 Reliability Standard does not set a frequency response expectation of one percent or greater, and FERC's Order No. 693 did not specifically direct NERC to modify the standard to contain a one percent frequency response requirement. If the Commission is now directing that NERC impose a frequency response requirement of one percent or greater of monthly peak load for all Balancing Authorities, this amount of frequency response is likely to be much greater than the actual amount necessary to achieve a reliable bulk power system, incurring significant costs beyond what may actually be required. More importantly, setting a one percent frequency response requirement is not currently achievable in the Eastern Interconnection without a dramatic shift in generator governor requirements relative to droop and deadband settings.

Accordingly, the Commission should grant clarification of or rehearing to revise the directives in Paragraph 18 of the March 18 BAL-003 Order to allow NERC the necessary time as proposed in this filing to address frequency response and develop modifications to the BAL-003-0 Reliability Standard that focus on incorporating those frequency response initiatives into the standard that are necessary to achieve a more reliable bulk power system. In this request for clarification and rehearing, NERC describes specific initiatives that it is undertaking to address frequency response, and is proposing to make two compliance filings with FERC to report on the

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[5] *See* March 18 Bal-003-0 Order at P 13 (citing Order No. 693 at P 373).

status and results of those initiatives. Additionally, in support of this clarification and rehearing request, NERC is including an affidavit prepared by Howard F. Illian on behalf of NERC, which is included as **Attachment A** to this filing.

a. <u>Issue 1: The Commission Incorrectly Concludes that the BAL-003 Standard Sets a Frequency Response of One Percent or Greater for all Balancing Authorities</u>

In the March 18 BAL-003 Order, FERC noted in Order No. 693 that the Commission concluded:

> We understand that the present Reliability Standard sets the required frequency response of the balancing authorities to be approximately one percent or greater by requiring that the frequency bias shall not be less than one percent and that the frequency bias be as close as practical to, or greater than, the actual frequency response.[6]

The Commission's conclusion is not accurate. The BAL-003-0 Reliability Standard requirements provide the following:

> **R2.** Each Balancing Authority shall establish and maintain a Frequency Bias Setting that is as close as practical to, or greater than, the Balancing Authority's Frequency Response. Frequency Bias may be calculated several ways:
>
> **R5.** Balancing Authorities that serve native load shall have a monthly average Frequency Bias Setting that is at least 1% of the Balancing Authority's estimated yearly peak demand per 0.1 Hz change.
>
> **R5.1.** Balancing Authorities that do not serve native load shall have a monthly average Frequency Bias Setting that is at least 1% of its estimated maximum generation level in the coming year per 0.1 Hz change.

Although these requirements clearly require a Balancing Authority to set and maintain a frequency bias setting, the current language in the standard does not require or suggest an actual frequency response equal to the one percent bias setting for each frequency event on the given

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[6] *See* March 18 BAL-003 Order at P 13 (citing Order No. 693 at P 373).

interconnection.[7] While FERC's March 18 BAL-003 Order directed NERC to modify the standard to incorporate a minimum level of frequency response, establishing a minimum bias setting does not also automatically establish a generator (and load) frequency response. The frequency bias setting has no effect on the actual primary (or natural) frequency response for a given Balancing Authority.

It is important to recognize the difference between "frequency response" and "frequency bias." Frequency response of the generators and load is the reaction of individual loads and generator controls to changes in frequency, operating in seconds without any manual intervention or directed action from an Automatic Generation Control ("AGC") program that typically acts on a fleet of units. Rather, primary frequency response is a function of the physics of the loads and the control systems of the individual generators (the majority comes from the generator governor control action). Frequency bias, however, is a control parameter used in the AGC and the Area Control Error ("ACE") equation of the Balancing Authorities that operates in the timeframe of minutes after the frequency disturbance.

The purpose of the frequency bias setting in the ACE equation is to keep the AGC systems from defeating the effects of the natural frequency response of the generators and load, which would occur if the AGC system was allowed to respond to the changes in tie line flows caused by a frequency disturbance occurring outside of its system. In other words, frequency bias settings used in the ACE equation are established so as not to allow the AGC system to counteract or to subsequently reduce the response that was provided through the governor actions of the generators. AGC action in this case also serves to restore the frequency to

[7] The Commission's March 18 BAL-003 Order does not meet the requirements of reasoned decision-making. *See, e.g., Motor Vehicle Mfrs.,* 463 U.S. 29, 43 (1983) (the Commission failed to engage in reasoned decision-making by not explaining this change in policy); *see also, Greater Boston Television Corp. v. FCC*, 444 F.2d 841, 852 (D.C. Cir. 1970).

approximate its pre-disturbance or target values. To achieve this, the absolute value of the bias term must be equal to or greater than the absolute value of the frequency response of the generators and load of the Balancing Authority.

Therefore, the overall frequency response and control actions in response to a sudden decline in bulk power system frequency must be broken down into the components that make up the response. These include:

- Inertial Response: The inertial response is the arresting response to the frequency decline of the overall system before any control action takes place. This occurs due to the rotating mass of the machines, both generators and loads such as motors, and occurs in milliseconds following a sudden drop in frequency.

- Primary or Natural Frequency Response: The Primary Frequency Response is the combination of generator governor and load response without human or programmatic intervention. In other words this occurs at the machine itself and not through the ACE equation where the frequency bias setting resides. This occurs in seconds based on control settings on the machines themselves such as droop and deadband. It should be noted that some generators are not equipped with governors and others, such as nuclear units, are not operated to be responsive to frequency due to other safety regulations. It is also not clear that the Commission's Large Generator Interconnection Procedures require the installation of governors.

- Secondary Frequency Response; AGC is applied by the Balancing Authority through its control system and the ACE equation. This is accomplished through the frequency bias setting and utilizes spinning reserves of Balancing Authorities. Longer term recovery is accomplished through deployment of contingency reserves and/or reserve sharing agreements to schedule replacement power.

Accordingly, because frequency response is a highly technical issue that is made up of several components, beginning with the initial response of generators and loads, determining an appropriate amount of frequency response that should be included as a Requirement of the BAL-003-0 Reliability Standard necessitates that appropriate studies and analyses be done to accurately determine the amount of frequency response needed for each Interconnection for reliable operation of the bulk power system.

NERC is in the process of developing studies and conducting analyses (discussed in further detail below) necessary to understand frequency response and characteristics of the current and expected types of generation and loads connected to the system that must be done before any standard frequency response performance target (of, for example, one percent) can be determined to be appropriate for an Interconnection. These studies and analyses must be performed before any standard requiring specific control settings for generator governor controls should be implemented to ensure that the actions are appropriate and do not expose the system to greater reliability risks. Following NERC's determination of an appropriate performance target, a mechanism must be devised to allocate the responsibility for that performance to each of the Balancing Authorities of that Interconnection. Additionally, the actions resulting from the studies may have impacts beyond the NERC Reliability Standards.

b. Issue 2: The Commission's Directive to NERC to Develop a Frequency Response Reliability Standard in Six Months is Unreasonable Given the Complexity of the Frequency Response Issue

Interconnection frequency response has been a subject of industry interest and attention since the first two electric systems became interconnected and the concept of frequency bias was adopted. In 1942, the first test to determine the system's load/frequency characteristic was conducted for use in setting bias control. As interconnected systems grew larger, and the characteristics of load and generation changed, it became apparent that guidelines were needed regarding frequency response to avoid one system imposing undue frequency regulation burdens on its interconnected neighbors.

During the 1970s and 1980s, NERC's Performance Subcommittee, charged with monitoring the control performance of the interconnections, noticed especially in the Eastern Interconnection that generators governor responses to frequency deviations had been decreasing.

The result was quite noticeable during large generation losses where the frequency deviation was not arrested as quickly as it once was. In 1991, NERC's Performance Subcommittee approached the Electric Power Research Institute ("EPRI") with a request to fund and manage a study of the apparent decline in governor response in the Interconnections. EPRI agreed and in turn contracted with EPIC Engineering to perform this study. The conclusions were captured in a joint EPRI/NERC report, *Impacts of Governor Response Changes on the Security of North American Interconnections*.[8]

The study determined that there were three primary reasons for declining governor response: 1) increased application of sliding pressure controls; 2) baseload nuclear generating units operated at maximum output; and 3) plant operators turning off governor controls. The study report included several recommendations to NERC, including:

1. Specify recommended governor criteria for droop and deadband standards;
2. Establish criteria with respect to governor response reserves; and
3. Gather and analyze frequency and ACE data to track performance over an extended period of time.

The NERC Operating Committee initiated changes to its then Operating Guides (later to become Operating Policies) to deal with these recommendations. Policy 1C[9] (discussed later in this filing) describes the guidance NERC provided.

In 2001, the NERC Resources Subcommittee (successor to the Performance Subcommittee) developed and posted for industry comment a Frequency Response Standard. The comments opposing the standard centered on: 1) those not understanding the proposed

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8 EPRI Report TR-101080, *Impacts of Governor Response Changes on the Security of North American Interconnections*, October 1992.

9 "Policy 1C" refers to one of several Policies contained in the North American Electric Reliability Council's Operating Manual, the primary document that contained NERC's guidelines and procedures during the pre-ERO voluntary regime.

metric; and 2) those questioning the reliability need for a frequency response standard because there was so much margin in the system.

In April 2004, the Frequency Task Force of the NERC Resources Subcommittee published a *Frequency Response Standard Whitepaper*[10] intended to create an understanding of the need for a frequency response standard and the technical and economic drivers motivating its development. The paper documented and discussed the decline in frequency response in the Eastern and Western Interconnections. As noted in the *Frequency Response Standard Whitepaper*, a number of complex and interrelated technical and economic issues must be considered in developing an efficient and effective frequency response standard. These issues, outlined below, must be carefully considered and weighed in developing an effective standard, which is why NERC is proceeding carefully and deliberately on this initiative.

- There must be a minimum response for each event (rate, amount, and duration). Reliance on average response could result in all areas being short at the same time. The amount (depth of response) should not be under-emphasized. One shortcoming of the recommendations in the former NERC policy is that there is no guidance regarding how much governor response (in MW) is required at the 5% droop rate. This has led to confusion among plant operators and turbine-generator manufacturers alike, and has resulted in an objectionable lack of response from some units when the boiler controls are suppressed out of legitimate fear of tripping the unit on a frequency change.

- The measurement selected must be accurate and, to the extent practical, easy to implement.

- The requirements must integrate with and be consistent with the assumptions used in setting the BAAL limits within the Load and Balancing Standard.

- A method of allocation must be developed.

- The standard should not preclude, and in fact should encourage, market solutions (*e.g.*, allow purchasing of response as long as deliverability and restoration criteria can be met). There must be a means for sale/purchase of frequency response as for

[10] NERC's *Frequency Response Standard Whitepaper is available at: http://www.nerc.com/docs/standards/sar/Frequency_Response_White_Paper.pdf*

any other quantity.

To the extent that market solutions are adopted to deal with frequency response as an ancillary service, these solutions will need to be incorporated into market rules adopted by the Commission. Attention will also need to be given to the existing generator interconnection standards approved by the Commission, as these generator interconnection standards may need to be modified to comport with the findings and recommendations of the NERC frequency response analyses and the Reliability Standard that results.

NERC recognizes the potential reliability risks with the continued decline of frequency response in the Eastern Interconnection and has recently taken action to address these potential reliability risks. However, the Commission's requirement that NERC determine within a six month-deadline the necessary amount of frequency response needed for reliable operation is unreasonable.[11] Rather, solving the problem of frequency response using a market solution with joint actions by both NERC and the Commission is superior to attempting to solve the problem with Reliability Standards exclusively.[12]

As explained below, NERC is currently in the process of undertaking a series of tasks that will result in a determination of what needs to be done to address frequency response, and anticipates that these specific tasks will be known within one year from the date of the March 18 BAL-003 Order. NERC will make a Compliance Filing with the Commission in six months to provide a status report on these tasks, and will make a compliance filing within one year to report on the results of the frequency response initiative and any next steps that will be necessary.

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[11] *See*, *e.g.,* 16 U.S.C. § 824o(d)(2)(2005) (requiring that "The Commission shall give due weight to the technical expertise of the Electric Reliability Organization with respect to the content of a proposed standard or modification to a reliability standard"); *see also, Chevron, U.S.A., Inc. v. Natural Res. Def. Council, Inc.*, 467 U.S. 837, 843 (1984) (courts and agencies are to "give effect to the unambiguously expressed intent of Congress.").
[12] This approach is explained in more detail in the Howard Illian Affidavit, included as **Attachment A** to this filing.

Significantly, NERC recently initiated a Frequency Response Initiative that will bring together several key activities underway on frequency response, including standards development project 2007-12, which is working to develop a frequency response standard, and Project 2007-05, which is working to develop standards related to Operating Reserves. NERC has developed a document outlining the objectives of the Frequency Response Initiative as well as an analysis of the tasks (near-term and long-term) that are currently being undertaken by NERC to address frequency response issues. This document is included as **Attachment B** to this filing**.**

In order to arrest the ongoing decline in frequency response, NERC plans on issuing a Recommendation to the Generator Owners and Generator Operators, in accordance with Section 810 of the NERC Rules of Procedure,[13] that will be based on the following previous NERC advice to these entities (as originally included in NERC Policy 1C). NERC will require that the Generator Owners and Generator Operators report back to NERC on their operating status with respect to these items.

- Governor Installation – Whether generating units with nameplate ratings of 10 MW or greater are equipped with governors operational for frequency response.

- Governors Free to Respond – Turbine governors and HVDC controls, where applicable, should be allowed to respond to system frequency deviation, unless there is a temporary operating problem.

- Governor Droop – All turbine generators equipped with governors should be capable of providing immediate and sustained response to abnormal frequency excursions. Governors should provide a 5% droop characteristic. Governors should, as a minimum, be fully responsive to frequency deviations exceeding ± 0.036 Hz (± 36 mHz).

[13] Section 810 of the NERC Rules of Procedure give NERC the authority, after analyzing a significant system event, to disseminate operations and equipment alerts that can require specific reporting actions by Bulk Power System users, owners, and operators.

- Governor Limits – Turbine control systems that provide adjustable limits to governor valve movement (valve position limit or equivalent) should not restrict travel more than necessary to coordinate boiler and turbine response characteristics.

These recommendations keep within the guidelines of the 2004 NERC Operating Policy 1 - Generation Control and Performance, section C. Frequency Response and Bias are also consistent with the Commission's Large Generator Interconnection Agreement.

NERC's Recommendation will require the Generator Owners and Generator Operators to verify whether they have governors installed operational for frequency response, and if so, to provide their governor control settings, including their deadband and droop settings. If an entity has a governor that is not required to be on for regulatory reasons, NERC will ask the generator to provide an explanation why. If a generator has a governor that is not on and operating, that generator will be asked to provide an explanation regarding why the governor is not operating. Entities will be asked that the responses to the Recommendation be provided to NERC within six months.

Additionally, on February 11, 2010, and revised on February 25, 2010, NERC issued an Alert, in accordance with Section 810 of the NERC Rules of Procedure, to Transmission Owners, Transmission Operators, Generation Owners, Generation Operators, Balancing Authorities, Reliability Coordinators, Load Serving Entities, and Distribution Providers describing a trend of natural interconnection frequency response deficiencies during the course of the last several years, demonstrated by multiple loss of resource (generation) events ("February 2010 Alert"). NERC requested in that Alert that each Balancing Authority review its own frequency response during frequency events, and review its related procedures for selecting and dispatching generation for providing primary frequency response, in order to promptly arrest frequency decline following an event to ensure reliable operations.

As a follow-up to NERC's February 2010 Alert, and in addition to the Recommendation described above, NERC also plans on issuing a survey to Balancing Authorities, to collect data that NERC can use to evaluate the level of measured frequency response in 2009, and how that response relates to the Frequency Bias settings selected for 2010 by the Balancing Authorities (*see* **Attachment B**, Near-Term Tasks). NERC will request that responses to the survey be provided to NERC within three months.

NERC will then combine the data from the survey into the Recommendation, and will analyze that data to determine what actions must be taken on frequency response, which may include other possible outcomes beyond Reliability Standard development. For example, there may be a need to engage generator equipment manufacturers, including wind, solar, and other emerging technologies regarding their control systems used to integrate these resources within the bulk power system. Changes may be necessary to Interconnection Agreements and tariffs to provide frequency responsive reserves. In some cases, the installation of governors or new control systems on key generation resources may be necessary. Additionally, work with other regulatory agencies, including the Nuclear Regulatory Commission ("NRC"), may be necessary to address Interconnection frequency response issues. Additional time may also be required to perform computer simulations of power system dynamics to analyze the inertial response issues. These analyses will address the potential impacts of the expected displacement of inertial generation with non-inertial resources on arresting frequency excursions in order to assure sufficient "headroom" from potentially impacting frequency sensitive load and resources.

NERC will address the results of these analyses in a compliance filing to the Commission within one year from the date of the March 18 BAL-003 Order. In NERC's one-year compliance filing, NERC will present a timeline explaining the remaining actions to be taken on frequency response and will present a proposed time for when those actions will be completed. In addition to the proposed one-year compliance filing, NERC will file a Status Report with the Commission within six months from the date of the March 18 BAL-003 Order describing the actions taken on frequency response to date and the general response from generators on the survey questions.

Within the Electric Reliability Council of Texas ("ERCOT") Interconnection and the Western Interconnection within the Western Electricity Coordinating Council ("WECC") region, additional work has taken place regarding frequency response. In both of these regions, the work focused on the responses to bulk power system frequency described above (*i.e.,* Inertial Response; Frequency Response; and Automatic Generator Control (AGC)). Based on this work, significant improvements in frequency response were achieved in ERCOT. NERC has reviewed the actions taken by ERCOT to address control settings within ERCOT and the responsiveness of the generation to a recent frequency event due to the tripping of a Generator and will evaluate these lesson learned in completing its own Frequency Response Initiative short-term and long-term tasks.

While some significant insights have been gained system-wide and technical improvements have been achieved in the Western Interconnection and ERCOT, NERC recognizes that a deeper and more dedicated effort is needed to fully address frequency response. Because the dynamics of the bulk power system are changing, NERC will study the effects of these changes in its Frequency Response Initiative and will address possible ways to deal with these dynamics in its evaluation of the study results that NERC will report to the Commission within one year from the date of the March 18 BAL-003 Order.

Accordingly, for the reasons described above, NERC requests that FERC grant clarification or rehearing of Paragraph 18 of the March 18 BAL-003 Order in order to provide NERC with sufficient time to conduct the necessary analysis on frequency response that must occur before modifications to the BAL-003-0 Reliability Standard can be made. As discussed above, NERC will file with the Commission two Compliance Filings – one in six months to describe the status of NERC's frequency response initiatives and the status of responses to the study, and another within one year from the March 18 BAL-003 Order to describe the analyses performed by NERC as a result of the responses to the frequency response survey that will provide recommendations on how frequency response should be addressed. NERC targets completion of a revised BAL-003 Standard within 18 months of the date of this filing.

Additionally, NERC requests that the Commission grant rehearing to consider the technical error in the March 18 BAL-003-0 Order in which the Commission noted that the present Reliability Standard sets the required frequency response of the Balancing Authorities to be approximately one percent of peak load, or generation. NERC respectfully requests that the Commission grant NERC an opportunity to conduct the necessary analyses to determine an appropriate frequency response level to be included in the BAL-003-00 Reliability Standard.

IV. CONCLUSION

For the reasons set forth in this filing, NERC requests that FERC issue an Order granting the Request for Clarification and Rehearing as set forth above.

Respectfully submitted,

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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 19th day of April, 2010.

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

ATTACHMENT A

Testimony of Howard F. Illian

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Order Setting Deadline for Compliance) Docket No. RM06-16-010

AFFIDAVIT OF HOWARD F. ILLIAN REGARDING MARCH 18, 2010 ORDER SETTING DEADLINE FOR COMPLIANCE WITH BAL-003-0 MODIFICATIONS

I. Introduction

My name is Howard F. Illian. My offices are located at 334 Satinwood Ct. N., Buffalo Grove, IL, 60089. I am employed by Energy Mark, Inc., and have been President since I established the company in October 1998. Energy Mark is a consulting firm that specializes in management consulting in the areas of electric power operations and electric power market design.

I began my employment in the electric utility industry with Commonwealth Edison Company (ComEd) in August 1968. I received my Bachelor of Science degree in Electrical Engineering in 1970 from Carnegie-Mellon University. During most of the first 15 years with ComEd I performed or supervised special studies in the area of strategic analysis supporting company executives, and provided expert analysis in Electrical, Mechanical and Chemical Engineering, Statistics, Accounting, Economics, Information Systems, and Operations Research. In 1984, I was assigned to the ComEd Power Supply Office as a Staff Engineer to manage the design and installation of a new Energy Management System (EMS). Early in that assignment, I was trained as a dispatcher. After the successful installation of the new EMS, I was promoted to Technical Services Director with full responsibility for facilities, hardware, communications, training, algorithms, economics, interchange settlement, software, and Research and

Development (R&D). I supervised a six person advanced R&D group in addition to the maintenance staff and training staff, and I was functionally responsible for the software development staff and the interchange settlement staff until my retirement in June 1998. I incorporated Energy Mark in October 1998. Energy Mark clients have included Allegheny Power, Ameren, Andersen Consulting (Accenture), California ISO, Cinergy, Edison Mission Energy, Midwest Generation, North-American Electric Reliability Council (NERC), Northern States Power, Electric Reliability Council of Texas (ERCOT)[1], North American Energy Standards Board, City of Garland Power and Light, US Department of Energy (DOE), Consortium for Electric Reliability Technology Solutions (CERTS), PUC of Texas, and the Federal Energy Regulatory Commission (FERC). In 1999, I began serving as a technical reviewer for the Institute of Electrical and Electrical and Electronic Engineers (IEEE) for technical papers on Power System Operations and have done so since. My resume' follows as Attachment HFI-1.

My career can be divided into three periods. I spent most of the first 15 years of my career working in the areas of accounting, statistics, econometrics, economics, information systems and operations research. During the next 15 years I worked in power system operations applying my economics and operations research experience to power system operations. In the mid 1980s I began working on the problem of frequency control, because I realized that efficient economic solutions for power system operations could not be consistently determined without a better technical basis for describing and measuring frequency control. During the last 12 years I have been in the unique position of having worked in both the fields of market economics and electric power system operations. This has been an ideal match for developing both the standards and market understanding necessary to implement workable standards and markets for

[1] ERCOT operates the electrical grid know as the Texas Interconnection.

energy and ancillary services, the services that I personally call reliability services, because they represent the price of reliability associated with frequency control in the power markets.

I have been working in the area of frequency control for over 20 years including work sponsored by ComEd, Electric Power Research Institute (EPRI), North American Electric Reliability Council (NERC), Institute of Electrical and Electronic Engineers (IEEE), Cigre[2], Consortium for Electric Reliability Technology Solutions (CERTS), United Stated Department of Energy (DOE), and the Federal Energy Regulatory Commission (FERC). My contributions in the area of frequency control include working on committees and projects including:

- EPRI Workshop on Automatic Generation Control (AGC, also referred to as Regulation): Priority Research Needs, 1991;
- NIPSCo[3]/Purdue/EPRI Research Project on Power Quality and AGC, 1992-1995;
- Industry/University/DOE/EPRI Research Center on AGC and Power Quality (ACEPS), 1993-1996;
- Technical Advisory Committee of the Control Criteria Task Force (CCTF) of the Performance Subcommittee[4] (PS) of the NERC Operating Committee, 1992-1998;
- Chairman of the ComEd AGC Task Force and developed methods to improve the ComEd control performance from 74% to over 90%, 1993-1995;
- MAIN[5] representative to the NERC Control Criteria Task Force (CCTF), 1994-1998;
- MAIN representative to the NERC Performance Subcommittee (PS) and developed the new control performance measures CPS1 and CPS2, 1995-1998;

[2] Cigre is the International Council on Large Electric Systems.
[3] NIPSCo is Northern Indiana Public Service Co.
[4] The NERC Performance Subcommittee is now called the NERC Resources Subcommittee.
[5] MAIN was the Mid-America Interconnected Network, a NERC Region.

- Elected the first chairman to the Frequency Task Force of the NERC PS, 1997-1998. I was the first to raise the issue of frequency control before Regulation responds, Frequency Response;
- MAIN Representative to the NERC Interconnected Operations Services (Ancillary Services) Implementation Task Force (IOSITF) responsible for developing technical definitions for the Ancillary Services, 1997-1999. I was the first to take the position that Frequency Response should be a separate and distinct Ancillary Service as compared to previous definitions that included it with Regulation. Frequency Response was defined as a separate and distinct service in the NERC Reference Document Interconnected Operations Services dated March 12, 2001;
- Co-sponsored a new task force on Frequency Response for the IEEE that published its Final Report on Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns, 2001-2007;[6]
- Identified the risk to ERCOT from insufficient Frequency Response and provided the basis for the subsequent Frequency Response requirements that have been added to the ERCOT Protocols, 2002;
- Developed the technical basis for the new NERC Balancing Authority ACE Limit (BAAL) currently under field testing on the Eastern Interconnection, 2004;
- Published numerous studies evaluating the reliability risk associated with interconnection frequency control for the three major North American interconnections[7] summarized in "Interconnections Frequency Response Research and Study", prepared for CERTS and

[6] All authors of this report were awarded the Technical Committee Working Group Recognition Award by the IEEE Power & Energy Society Power System Dynamic Performance Committee.

[7] The three major North American interconnections are the Eastern Interconnection, the Western Interconnection, and the Texas Interconnection.

the NERC Frequency Response Standard Drafting Team, September 30, 2007, funded by DOE;

- IEEE Task Force on Turbine Governor Modeling, 2007-Present;
- Chairman of the IEEE Task Force on Measurement, Monitoring, and Reliability Issues Related to Primary Governing Frequency Response, 2007-Present;
- NERC Frequency Response Standard Drafting Team, 2007-Present;
- NERC Reliability Based Controls Standard Drafting Team, 2007-Present;
- NERC Balancing Authority Controls Standard Drafting Team, 2007-Present;
- Presented "Power System Stability/Instability" related to the variable generation provided by renewables for the IEEE-USA[8] at the American Institute of Chemical Engineers (AIChE) Spring National Meeting on the need for Mass Electricity Storage: Fixing Renewable Power's Achilles Heel;
- Cigre Working Group C4.601, Analytical Techniques and Tools for Power Balancing Assessment, 2008-Present;
- Cigre Working Group C4.603, Review of Potential Tools and Techniques for Risk Based and Probabilistic Planning in Power Systems, 2008-2010;
- ERCOT Frequency Response Standard Drafting Team, 2008-Present;
- Contracted with FERC to repeat and expand the work presented in the "Interconnections Frequency Response Research and Study" by adding data and analysis for the calendar year 2007 and 2008.
- Served as an expert witness on Frequency Response and Frequency Bias before the Public Utility Commission of Texas during 2008 and 2009.

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[8] IEEE-USA is an organizational unit of the IEEE supporting the career and public policy interests of IEEE's U.S. members.

- I am under contract with CERTS to provide consulting services to accelerate the completion of the NERC Balancing Standards currently under revision.

II. Summary

The purpose of this affidavit is to provide a technical perspective on behalf of the North American Electric Reliability Corporation ("NERC") of the Federal Energy Regulatory Commission's ("FERC") March 18 BAL-003-0 Order directing NERC to submit a modification to the BAL-003-0 Reliability Standard to the FERC within six months. FERC directed NERC to define the necessary amount of frequency response needed for the reliable operation for each balancing authority with methods of obtaining and measuring that the frequency response is achieved. After review of the FERC's March 18 BAL-003-0 Order, I found that order to be a highly oversimplified presentation of the problem that the industry faces with respect to Frequency Response. I have included four main points in my discussion of this order, although many more deficiencies exist. The first two points address the oversimplification problem, the first addressing the order itself and the second addressing the foundation for this order, FERC Order No. 693. The second two points address the technical reasons that created this serious reliability situation in the first place. It is my expert opinion that the industry will be unable to achieve the reliable operation of the bulk power system unless all four of the issues are addressed in a timely manner.

What is Frequency Response?

In this Order, Setting Deadline for Compliance the term Frequency Response is used throughout the document in two different and distinct contexts that are both components of Primary Frequency Control. As a result, the order over simplifies the problem and creates confusion with respect to the requirements to comply with the order. The two different and distinct contexts for Frequency Response are the Arresting Frequency Response and the Settling Frequency Response. The Settling Frequency Response is the traditional Frequency Response that has been used for decades in the industry as Frequency Response and Primary Frequency Control. It is also the Frequency Response that is used to as the basis for setting the Frequency Bias term in Tie-line Bias Control and is the Frequency Response referred to in BAL-003. The Arresting Frequency Response is the amount Frequency Response that has been applied at the exact instant when a change in frequency from a disturbance event is arrested and the frequency begins to recover. The Arresting Frequency Response is the Frequency Response of interest when considering reliability with respect to frequency error is also included within Primary Frequency Control. When these two different and distinct components of Primary Frequency Response are described using the same term, the result is an oversimplification of the problem.

Settling Frequency Response has been measured in the industry for decades. The methods used to measure Settling Frequency Response are well known, and as part of its work, the NERC Frequency Response Standard Drafting Team has recently standardized the measurement of Settling Frequency Response to insure consistency and comparability of measurements of this important parameter.

The industry is just beginning to develop measurement methods for Arresting Frequency Response in recognition of the important part it plays in reliability. The measurement of Arresting Frequency Response requires high speed measurement equipment surrounding any area of an interconnection to measure the Arresting Frequency Response for that area of the interconnection. The current measurement infrastructure in the electric utility industry is incapable of supporting the widespread measurement of Arresting Frequency Response. The industry currently has only limited capability of measuring Arresting Frequency Response for portions of the full interconnection. This means that only selected generating plants and a few Balancing Authorities have the metering infrastructure to support the measurement of Arresting Frequency Response. Thus the lack of ability to measure the Arresting Frequency Response could be a significant barrier to the development of a reliability standard that would assure reliability provided by Arresting Frequency Response.

Bypassing the ANSI Process:

When FERC Order No. 693 was issued a significant precedent was set that is highly detrimental to the standards process. In that order, the Commission inappropriately added a requirement to the NERC standards requiring that the frequency response of the balancing authorities to be approximately one percent or greater by requiring that the frequency bias shall not be less than one percent of peak load and that the frequency bias be as close as practical to, or greater than, the actual frequency response. Since that order was issued, NERC has provided an interpretation of this requirement with respect to BAL-003, which is in progress. Preliminary findings of that interpretation are that BAL-003-0.1b does not have any requirements mandating a specific magnitude of Frequency Response by the Balancing Authority. As an expert in this field and as a continuous participant in the standards writing process for this standard or its equivalent since the early 1990s, I strongly support this view that BAL-003 does not present a frequency response requirement.

Any standard that addresses the reliability issues associated with Frequency Response must address both components necessary for the delivery of Frequency Response. The first component of Frequency Response is the proportional delivery of response in relation to the change in frequency. This proportional delivery of response is expressed in MWs per 0.1 Hz. This is the normal measure used to define Frequency Response because it is the value used to estimate Frequency Bias to which the 1% minimum applies. The second component of Frequency Response is the depth of response available to be delivered that opposes frequency change and is measured in MWs of reserve or margin. Only the coordinated delivery of Frequency Response, limited by both components, can assure reliability. If the proportional delivery of response is above the minimum required, but the depth of response is limited because insufficient margin is reserved to allow for the delivery of the response, reliability cannot be maintained. If the depth of the response margin is above the minimum required, but the proportional delivery of response is insufficient to deliver the required response, available from the margin set aside, reliability cannot be maintained. The requirement added to BAL-003 by Order No. 693 only addresses the proportional delivery component of response and as such cannot assure reliability. It does not address the required depth of response that is necessary to maintain reliability.

The coordinated component delivery discussed above is similar to the other Ancillary Services in that the proportional response component is largely dependent on the setting and enabling of generator governors. The delivery margin component is dependent upon how the BA sets-up the system and allocates reserves and response margins among the generators that provide governor response.

The delivery of Regulation has similar coordination component delivery problems. Regulation is dependent upon the ramp rates of the generators delivering Regulation and upon the BA system set-up that allocates reserves and response margins among the generators that provide Regulation. It has been demonstrated that Regulation can be effectively delivered through the implementation of Ancillary Service markets. The effective delivery of an Ancillary Service, called Frequency Response, could be enabled through the implementation of a market in

Frequency Response where the Balancing Authority acquires both necessary proportional response and necessary reserves and response margins from the generators through the market mechanism.

Implementation of the market in a Frequency Response Ancillary Service cannot be initiated by NERC through a reliability standards process. Only the Commission has the authority to promulgate the rules that would achieve this goal.

Without a market in Frequency Response, the only alternative available to NERC is to create standards that:

1. Require generators to provide governor response without appropriate compensation and to provide additional reserves and response margins without compensation, and
2. Require Balancing Authorities to perform system set-up in a manner that insures the reserve and response margin allocations are sufficient to deliver the required Frequency Response without appropriate economic price signals to guide the efficient allocation of those reserve and response margins.

In light of the extensive actions that the industry has taken to implement restructuring since Order No. 888, the alternative of solving the problem of Frequency Response using a market solution with joint actions by both NERC and the Commission is far superior to attempting to solve the problem with reliability standards exclusively.

A review of the technical basis for the Commission setting a 1% minimum frequency response requirement indicates that the 1% of peak load value first appeared in the records in a NAPSIC Operating Manual dated September, 1964 and this requirement has simply not changed since that time. The NAPSIC decision to include this 1% minimum bias requirement was an arbitrary decision without technical merit. This is hardly the kind of sound technical basis that the industry should be setting its reliability standards upon. This lack of sound engineering basis would likely not pass the key factors identified by FERC in Order 672 for standard approval. What happened in this case?

When standard requirements are set in a manner that bypasses the NERC ANSI Process for standard development, the industry also bypasses the technical peer review that is also part of that NERC ANSI Process. There are sound technical reasons for peer review to exist. This is demonstrated by the use of peer review in almost every technical publishing arena. FERC also notes the value of peer review in certain of the other Order 693 directives regarding transmission planning processes. Regarding BAL-003-0, it is highly unlikely that the 1% minimum frequency response would have survived the NERC ANSI Process intact. This example clearly demonstrates the need to continue to support the NERC ANSI Process as the only one that should be used for the development of reliability standards in our industry.

Further, many in this industry assume that when a reliability standard is written the natural result will be an improvement in reliability related to the requirements in the standard. Experience indicates that in some cases when insufficient knowledge is acquired before writing a standard, the consequences of implementing the standard can be detrimental to reliability. For example, I believe this has been demonstrated with the first attempt Texas and ERCOT made when they attempted to write and enforce frequency response policies and protocols.[9,10] In this specific case, the policies and protocols were detrimental to reliability because the provisions associated with dead-bands created frequency instabilities on the interconnection that were detrimental to reliability. This could have been prevented if the dead-band specified in the

9 Illian, H.F., Rebuttal Testimony of Howard F. Illian, PUC of Texas Docket No. 34738, Item No. 303, February 18, 2009.

10 Illian, H.F., Integrating Variable Renewable Energy Resources into the Smart Grid, Carnegie Mellon University Transmission Conference, March 10, 2009.

policies and protocols received comprehensive technical review and consideration of the consequences before implementation. They are now correcting those problems with a new standard subject to a more comprehensive review process similar to the NERC ANSI Process. This example demonstrates that standard writing is not a trivial process and does not always result in reliability improvements.

What is the root cause of the frequency response problem?

As the industry moves to address this important reliability problem, it is important to understand the technical reasons for declining frequency response. In the early 1990s, studies performed by EPRI indicated that the frequency response of the interconnections was declining below levels that would be expected with a growing industry. Although frequency response was declining, the opinion of experts was that the declines had not reached a point where reliability was being compromised. Since these initial studies were performed, the industry has continued to experience declining frequency response, but of greater concern has been the fundamental change is the shape of the frequency response characteristic on the Eastern Interconnection. The frequency response characteristic has changed from one that exhibits a definite arresting and recovery in frequency to one that has an indistinct arresting and additional decline. This demonstrates the delivery of primary frequency response to arrest the initial deviation. It also demonstrates the delivery of additional primary response after the frequency deviation is arrested to achieve a settling level closer to scheduled frequency. It is my expert opinion that this fundamental change in the nature of frequency response is the result of specific actions taken by the industry to limit and actually withdraw frequency response provided by generators. To understand why this fundamental change has taken place we need to look at the changes that have taken place in the industry over the last 15 years when these changes in the fundamental frequency response characteristic took place.

When industry restructuring began with the issuance of Order No. 888, it was recognized that the unbundling of specific services was necessary to maintain reliability. These services were called Ancillary Services by FERC and Interconnected Operations Services (IOS) by NERC. Unfortunately, the defined services did not include the separate and distinct service of Frequency Response. Order No. 888 inappropriately classified Regulation and Frequency Response together, and the initial list of IOS from NERC failed to include Frequency Response at all. As a consequence, the industry developed delivery rules and tariffs that failed to include any provision for the delivery of Frequency Response. As a consequence, market rules and tariffs were promulgated that could actually penalized the delivery of frequency response. This problem was not recognized by the industry until the NERC Reference Document Interconnected Operations Services was issued in March, 2001. By that time most of the damage to discourage the delivery of frequency response had already been done.

Although NERC recognized this failure in approach long ago, FERC has yet to adjust its tariffs and tariff setting policies to address this important issue. The Ancillary Services have not been modified to recognize Frequency Response as a separate and distinct service. The policies for determining the energy imbalance penalties and adjustments have not been modified to insure that the provision of Frequency Response is not penalized financially. In fact, the Texas market is the only market that has made appropriate adjustments in the market rules to insure that the provision of Frequency Response is not penalized. They have done this by including a term in their imbalance tariffs to represent Frequency Response in a manner similar to the representation used in the Frequency Bias term of the ACE Equation. The Commission has chastised NERC for taking three years to write a standard on the highly complex subject, but the Commission has failed to act for over nine years to address that same subject in its tariffs.

Were NERC to act today to issue a standard requiring minimum frequency response, that standard would have its effect continue to be influenced detrimentally by the potential penalties that still exist when frequency response is provided. It will simply not be enough to modify the reliability standards to require the provision of this service, the market rules and tariffs must also be change to insure that its provision is not penalized. This will take concurrent action by the Commission to address this issue separate from the development of a reliability standard. This indicates the need for a more thoughtful, collaborative process with FERC to affect the positive impact on frequency response being directed in the order.

Additional efforts are required to solve the problem?

We must recognize that there is significant momentum in the electric utility industry. Had the importance of frequency response been recognized as such and acted upon ten years ago, the industry would have likely continued to act as it always had and continued to provide frequency response from most of its generators through force of habit. Unfortunately, the industry is now in the position that force of habit will be to continue to cause withdrawal of frequency response. Under these circumstances, it will take more than simply removing the incentive not to provide frequency response to put the industry in the desired position.

The industry needs to take a positive step to encourage suppliers to provide frequency response by insuring that ancillary services markets include frequency response as a distinct and separate ancillary service. If markets were to include frequency response as a separate and distinct ancillary service, it would be priced at its value to the system. Failure to take this additional step will only encourage the providers to substitute secondary control services for frequency response to the detriment of reliability because current market designs fail to differentiate frequency response from secondary control service by price. The technical basis for taking this action was provided in my testimony before the PUC of Texas in 2009.

III. Conclusion and Recommendation

Based on my experience in this area, I strongly encourage and support efforts to develop a collaborative multi-faceted approach to fully and completely address the problem of declining frequency performance. With respect to the six month deadline for submission of a modification to BAL-003, I am in favor of and support the Commission's concern in timely addressing this important reliability issue, but I offer two important caveats. First, there is basic research that must be performed before the specified standard can be completed. This basic research must reveal answers to the following issues:

1. Developing Standard Definitions for Frequency Response:

   Develop standard definitions and categories for Frequency Response that can be implemented continent wide and provide specific guidance on what characteristics are required for a resource to provide frequency response that can contribute to meeting the Minimum Frequency Response Limit.

2. Measuring Arresting Frequency Response:

   Confirm that the Arresting Frequency Response can be adequately measured for standard enforcement purposes by measuring the Settling Frequency Response at the Balancing Authority level and correlating that response to the Arresting Frequency Response as measured interconnection wide.

3. Determining Scenarios for Interconnection Reliability:

Determine all of the scenarios for interconnection reliability associated with the delivery of Frequency Response. Three have been identified:

a. The minimum frequency response required to insure appropriate reliability on an intact interconnection,

b. The minimum frequency response required to insure appropriate reliability for regions of an interconnection that has experienced separation, and

c. The minimum frequency response to insure that a properly coordinated under-frequency relay implementation has a reasonable probability of being successful.

Additional contributors may be identified as part of the NERC ANSI Process.

4. Setting Minimum Frequency Response Limits:

   Set Minimum Frequency Response Limits at the interconnection, regional and Balancing Authority level for each of the above scenarios based on the conditions associated with each scenario.

5. Allocating Minimum Frequency Response Limits:

   Where necessary, develop allocation methods to distribute the interconnection Minimum Frequency Response Limit among the Balancing Authorities in relation to their contribution to the reliability risk they contribute for each specific scenario.

6. Categorizing Frequency Response:

   Specify how each of the Frequency Response categories must be included in the control and performance equations and measures, including the ACE Equation and the CPS1 Equation.

7. Modifying Frequency Bias Setting Methods:

   Completion of item 6 will also require the modification of the methods used to estimate Frequency Bias currently included in BAL-003.

In November, 2009, I created a work plan that included the above basic research goals with the intent of completing this research prior to October, 2010. I believe most of this basic research can be completed within this time frame, but the Commission must also recognize this is knowledge we do not possess and, as such, failure to complete this research in that timeframe for inclusion in this standard could delay the standard development. Second, the NERC ANSI Process is both a consensus and a peer review process that takes time and effort to complete. The risks of moving forward with a new standard before it has completed the NERC ANSI Process are a greater threat to reliability than many would estimate. We should not implement any standard that has not cleared the NERC ANSI Process. I believe it would be appropriate for the Commission to stay the order in place, and consider these two caveats as valid reasons for granting extensions to the deadline.

Both NERC and the Commission have active roles to play in the ultimate solution to the reliability problems being addressed by the Order Setting Deadline for Compliance. The problem cannot be effectively solved by writing a new reliability standard to address the provision of frequency response alone. Other actions must also be taken to insure that the new reliability standard is not weakened by other existing rules that are beyond the purview of NERC.

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Order Setting Deadline for Compliance) **Docket No. RM06-16-010**

AFFIDAVIT OF HOWARD F. ILLIAN REGARDING MARCH 18, 2010 ORDER SETTING DEADLINE FOR COMPLIANCE WITH BAL-003-0 MODIFICATIONS

State of Illinois)

County of LAKE)

I, Howard F. Illian being duly sworn, state that the contents of the foregoing Affidavit on behalf of the North American Electric Reliability Corporation are true, correct, accurate, and complete to the best of my knowledge, information, and belief:

Howard F. Illian

Subscribed and sworn to before me this 13 day of April, 2010.

My Commission expires: 03.13.2013

Notary Public

OFFICIAL SEAL
Sylwia Pacyk
Notary Public, State of Illinois
My Commission Exp. 3/13/2013

Howard F. Illian

334 Satinwood Court North • Buffalo Grove, IL 60089
(847) 913-5491 (847) 910-9510 Cell
Howard.Illian@EnergyMark.com

SUMMARY: Research and implementation expert in multiple disciplines including Electrical and Mechanical Engineering, Reliability, Economics, Statistics, Accounting, Operations Research, Information Systems, Human Factors and Training. Experienced at developing, implementing and managing solutions for technical and business problems, previously considered difficult or impossible to solve.

EXPERIENCE:

1998–Present: Energy Mark, Inc. – President

Founded a general consulting practice in energy markets with special concentration on system operations. Clients include Allegheny Power, Ameren, Andersen (Accenture) Consulting, Cinergy, Edison Mission Energy, Midwest Generation, North-American Electric Reliability Council, Northern States Power, Electric Reliability Council of Texas, North American Energy Standards Board, City of Garland Power and Light, US Department of Energy, Public Utility Commission of Texas, Federal Energy Regulatory Commission and Consortium for Electric Reliability Technology Solutions (CERTS).

1998 June-October: Cirrus Technologies, Inc. – Vice President & Electric Operations Practice Manager

Started an Electric Operations Consulting Practice.

1968-1998: ComEd

1991-1998: Technical Services Director - ***Bulk Power Operations***

Anticipated needs of the business unit and had workable solutions ready when required in an environment where most solutions require a high level of technical knowledge in multiple disciplines where 50% required R&D. All solutions were practical because they were implemented. Technical liaison between business unit and Information Systems. Oversaw 24 x 7 computer, communications & facilities support, including design, installation, trouble shooting and maintenance of real-time computer and communications systems.

- **Active integrated research, development and implementation initiatives:** (details available on request)
  - Automatic Generation Control (9 components, 7 completed)
    - Savings to ComEd of $25 million in annual fuel costs
    - Savings to North American electric power industry of $250 million annually
  - Transmission Management and Pricing (7 components, 4 completed)
  - Supply Economics (7 Components, 5 completed)
  - Market Applications (5 Components, 5 completed)
  - Demand Economics (4 Components, 2 completed)
  - EMS/SCADA Architecture (6 components, 2 completed)
  - Managed Development of Formal Training Program for all Dispatch Center Personnel.

1984-1990: Staff Engineer, 1 of 3 Members EMS Task Force - ***Bulk Power Operations***

- Project Manager, EMS Testing & Start-up 1989-1990
- Designed & implemented dispatch room and consoles 1987-1989
- Designed & implemented MMI and One-Line Systems 1987-1989
- Approved all applications logic, methods and implementation for EMS 1986-1990
- Created first ComEd Interchange Billing & Analysis Program 1986
- Performed first formal task analysis of ComEd Bulk Power Operations 1984

1976-1983: Supervisor, Economic Research and Load Forecasting - ***Strategic Analysis***

- Supervised the completion of special studies for the company executives and business units
- Participated in the sale and lease-back of over $500 million of distribution equipment 1979
- Created and implemented successful ComEd strategy for testimony before the ICC concerning the completion of Byron and Braidwood nuclear stations 1978
- Collaborated with Vice Chairman Gordon Corey in preparing comprehensive analysis of nuclear power to present to Marvin Leiberman, Chairman, Illinois Commerce Commission. Approved final draft for issue 1976

1973-1975: Project Manager - ***Transportation***

- Designed the Transportation Fleet Management Information System for ComEd used from 1976-1996

1970-1973: Economic Research Analyst - ***Strategic Analysis***

- Performed Special Studies for ComEd Strategic Planning

1968-1970: Engineer - ***Distribution Engineering***

- Project Engineer for Design and Installation of Transmission Substations
- Determined thermal ratings of electrical equipment

AWARDS:

- Greatest Intellectual Contribution to the Generation Commercial Management Project 1997
- ComEd Individual Excellence Award 1997
- ComEd Individual Excellence Award 1996
- ComEd Individual Excellence Award 1995
- Trade Secret Status and Financial Awards for Development of Applied Mathematical Techniques to Simulate Generation Availability 1980
- Technical Committee Working Group Recognition Award, for "Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns," by the Power System Dynamic Performance Committee, at the IEEE PES GM, Pittsburgh, Pa., July 2008.

EXPERT WITNESS:

- Frequency Response, Compliance Hearings, Texas PUC, 2008 to 2009
- EMS Delivery, Allegheny Power Co., 2000
- Financial Damages, Zion Load Following Suit 1982
- Economics, Illinois Commerce Commission - Using Engineering Economics to Determine Optimal Capital Structure 1982
- Financial Damages, Consolidation Coal Suit 1982
- Engineering Economics, Federal EPA on Appendix A of the Clean Air Act, Section 120, Noncompliance Penalties Technical Support Document (Penalty calculations for delayed compliance penalties) 1979
- Engineering Economics, Powerton Coal Conversion Hearings, Illinois EPA 1973

EDUCATION:

- Carnegie Mellon University, Bachelor of Science, Electrical Engineering

RESEARCH & DEVELOPMENT: (details available on request)

- Contributed over 21 significant new research results

SPECIAL ACCOMPLISHMENTS: (details available on request)

- Founded two National Organizations
- Served on over 25 ComEd, 4 Regional, 22 National and 2 International Task Forces

TEACHING: (details available on request)

- Guest lecture for University Graduate Programs
- Participated in expert panels discussions at Electrical Utility conferences

PUBLICATIONS: (details available on request)

- Author of over 100 technical publications, presentations and books

OTHER ACHIEVEMENTS:

- Coach, Illinois Institute of Technology Varsity Diving Team 1993-1995
- Head Coach, Oak Park Strikers Soccer Team 1987-1992
- Team and Coaching Coordinator, Oak Park Strikers Soccer Club 1986-1989
- Recipient of the Illinois Governor's Award for Volunteer Service 1986
- Finalist for Illinois Volunteer of the Year 1986
- Founder and Head Coach, Oak Park YMCA Boys Gymnastic Club 1984-1986
- Manager and Head Coach, Oak Park YMCA Girls Gymnastic Club 1980-1986
- Co-Founder Oak Park Strikers Soccer Club 1979
- Community Liaison, Oak Park School Board District 97
- Advisory Committees, Oak Park School Board District 97
- Co-Founder & Co-Chairman Oak Park Blood Assurance Program 1974-1977
- Chairman Oak Park Revenue Sharing Task Force 1972-1975
- Co-Chairman Carnegie Mellon University Alumni Committee 1971-1976

EXPERIENCE (details)

- **Integrated Research Initiatives:**
  - Automatic Generation Control (9 components, 7 completed)
    - Created a new mathematical foundation for Control Theory.
    - Created method to measure the contribution of each generating unit to the total control of the control area and used that method to measure and improve the ComEd control performance from 74% to 90+%.
      - Savings to ComEd of $10 million in annual fuel costs.
    - Negotiated use of new Control Theory as a basis for the NERC Control Performance Standard.
      - Additional savings to ComEd of $10 to $15 million in annual fuel costs.
      - Savings to North American electric utility industry expected to be more than $250 million annually.
    - Used new Control Theory to develop a marketable product in frequency control enabling any customer or generator to participate in the maintenance of interconnection frequency.
    - Designed marketable products in real energy ancillary services using the new Control Theory.
    - Designed markets in reliability using the new products to enable the transition from a regulated to an unregulated industry while maintaining reliability.
    - Developed theories to enable AGC to become fully driven by economic algorithms.
    - Control Area Services Pricing
    - Investigating ways to use the new Control Theory to improve control methods outside the electric utility industry.
  - Transmission Management and Pricing. (7 components, 4 completed)
    - Distributed Advanced Security Applications
    - Upgrade Advanced Security Applications
    - Dispatcher Training Simulator
    - Constrained Optimal System Scheduling
    - Transmission Congestion Pricing
    - Available Transfer Capability
    - Free Market Transmission System Pricing
  - Supply Economics. (7 components, 5 completed)
    - Created & Implemented Heat Rate Adjustments
    - Created & Implemented Fuel Scheduling
    - Automated Incremental Cost Report
    - Contributions to Kincaid / State Line Contracts
    - Completed Market Interface to Generation Commercial Management System
    - Heat Rate Scheduling
    - Constrained Optimal System Scheduling
  - Market Applications. (5 components, 5 completed)
    - Created & Implemented Minimum & Start-up Billing
    - Rewrote Production Data Base
    - Significant Contributions to ComStar Creation
    - Significant Contributions Electric Pricing Model
    - Implemented Interchange Scheduling & Settlement
  - Demand Economics. (4 components, 2 completed)
    - Significant Contributions to Rider 30
    - Significant Contributions to Real Time Pricing
    - Demand Pricing Curve Development
    - Designing Systems for Direct Access
  - EMS/SCADA Architecture. (6 components, 2 completed)
    - Developed EMS MMI Emulator
    - Energy Management System Replacement Design
    - Common Information Model (CIM) and CCAPI
    - UCA
    - Concept Substation
    - Common MMI and Information Presentation

RESEARCH & DEVELOPMENT CONTRIBUTIONS

Contributed over 25 significant new research results.

1. Developed method to unify scheduled and unscheduled energy for transmission flow management. 2009
2. Identified Precursor Frequency Excursion Risks for North American Interconnections. 2007
3. Developed market structure for decentralized market for unscheduled energy settlement. 2004
4. Developed the Balancing Authority ACE Limit (**BAAL**) currently under field test by NERC. 2004
5. Developed method to unify the settlement of Inadvertent and Energy Imbalance. 2001
6. Developed method to measure delivery of Ancillary Services for NERC IOSITF. 1999
7. Developed market model for enabling market managed reliability. 1998.
8. Developed mathematical descriptions for Ancillary Services. 1998.
9. Decomposed the Control Performance Standard to describe Real-energy Ancillary Services. 1998
10. Developed new mathematical foundation for general control theory. 1995.
11. Developed theoretical basis for new Control Performance Standard. 1995.
12. Demonstrated non-linear frequency response characteristic for ComEd and the Eastern Interconnection. 1994.
13. Demonstrated frequency characteristics of ACE covariance on the Eastern Interconnection. 1994.
14. Developed concept of Regulating Performance Value to measure unit contribution to AGC performance. 1992.
15. Discovered new method for assuring convex economic supply curves for generators. 1991.
16. Supported successful work on unit scheduling and commitment. 1990-1991.
17. Developed recursive probabilistic methods to value the Start-up Risk Costs for generating units. 1982.
18. Discovered and developed new applied mathematics methods to simulate the forced outage of generating unit equipment. Was awarded trade secret status for this work. The ComEd Reliability and Betterment Section was created as a result of this work. 1980.
19. Developed methods to evaluate the value of below market debt in economic studies. 1979.
20. Demonstrated feasibility of using Probabilistic Simulations Techniques for generation planning. 1973. The ComEd Generation Planning Section was created as a result of this work.
21. Demonstrated feasibility of including system fuel costs in studies for selecting new generating units. 1972
22. Consolidated and documented methods for analyzing the economic effects of Financial Leases. 1971
23. Use of compression connectors in substation ground grids. 1970
24. Wrote <u>first</u> computer program in the industry to calculate thermal ratings of three winding transformers. 1969
25. Compiled and analyzed research data collected over many years by CECo engineers on the ratings of copper and aluminum bus-bars. Confirmed the consistency of the data using statistical methods. Organized and presented the data in an easy to use format. June 1969

WORK CONTRIBUTIONS & SPECIAL ACCOMPLISHMENTS

Founded two National Organizations and Served on over 25 ComEd, 4 Regional, 25 National, and 5 International Task Forces or Committees

- Member ERCOT Frequency Response Standard Drafting Team. 2008 present
- Member Cigre Working Group C4.603, Analytical Techniques and Tools for Power Balancing Assessment. 2008 present
- Member NERC Balancing Authority Controls Standard Drafting Team. 2008-present
- Member NERC Reliability Based Control Standard Drafting Team. 2007-present
- Member NERC Frequency Response Standard Drafting Team. 2007-present
- Member NERC Balancing Authority Controls SAR Drafting Team. 2007-present
- Member Cigre Working Group C4.601 on Power System Security Assessment. 2007-present
- Chairman IEEE Task Force on Measurement, Monitoring and Reliability Issues Related to Primary Governing Frequency Response. 2007-present
- Member IEEE Task Force on Turbine Governor Modeling. 2007-present
- Member NERC Reliability Based Control SAR Drafting Team. 2007-2007
- Independent Representative to NAESB Inadvertent Interchange Payback Task Force. 2003-2006
- Independent Representative to NERC Joint Inadvertent Interchange Task Force. 2001-2002
- Member IEEE Task Force on Large Interconnected Power System Response to Generation Governing. 2001-2007
- IEEE Technical Paper Reviewer for papers on System Operations. 1999-present
- Independent Representative to NERC Interconnected Operations Services Metrics Task Force 1998-1999
- Independent Representative to NERC Interconnected Operations Services Implementation Task Force 1998-1999
- ComEd ARES (Direct Access) Task Force 1998

- ComEd/MAIN Representative to NERC Interconnected Operations Services Implementation Task Force 1997-1998
- ComEd SO2 Allowance Strategy Task Force 1997-1998
- ComEd EMS Replacement Task Force 1997-1998
- ComEd Representative to MAIN Guide 5B, Reserve Sharing, Task Force
- Member Infrastructure Working Group, Midwest Independent System Operator 1996-1998
- Member Administrative Working Group, Midwest Independent System Operator 1996-1998
- Team Leader ComEd Production Database Administrative Team 1996-1998
- Member ComEd T&D, New Technologies Subcommittee 1995-1998
- ComEd Representative EPRI DYNAMICS Owners' Group 1995-1998
- ComEd Representative EEI Transmission Subject Area Committee 1995-1998
- ComEd Technical Advisor, Real Time Pricing Task Force 1995-1998
- ComEd Technical Advisor, Transmission Switching Project 1995-1998
- ComEd Technical Advisor, Generation Commercial Management System 1995-1998
- ComEd Fossil Operations Information System Task Force 1994-1998
- MAIN Representative Control Criteria Task Force, NERC Performance Subcommittee 1994-1998
- Technical Advisory Committee, Control Criteria Task Force, NERC Performance Subcommittee 1992-1998
- MAIN Compliance Subcommittee 1995-1997
- MAIN Representative to NERC Performance Subcommittee 1995-1997
- ComEd Production Database Administrative Redesign Committee 1996
- ComEd NEETRAC R&D Task Force 1996
- ComEd ComStar Model Design Team 1995-1996
- ComEd Fossil Strategic Planning Task Force 1995-1996
- ComEd FERC CRT NOPR Task Force 1996
- Founder and Member, Industrial Advisory Board of Industry/University/DOE/EPRI Research Center on AGC and Power Quality (ACEPS) 1993-1996
- ComEd Chairman, Automatic Generation Control Task Force 1993-1995
- ComEd Project Manager, Illinois Institute of Technology Unit Commitment & Scheduling R&D Project 1995
- ComEd Project Manager, Production Database and Interchange Billing & Analysis System Rewrite 1994-1995
- ComEd Sponsor, EMS Distributed Advance Security Applications Task Force 1992-1994
- NIPSCo/Purdue/EPRI Research Project on Power Quality and Automatic Generation Control 1992-1995
- ComEd Sponsor and Advisor, Production Database Business Area Analysis 1993
- ComEd Distribution Task Force 1991-1993
- EPRI AGC Task Force 1991
- ComEd EPRI Pilot Technology Transfer Project Task Force 1991
- ComEd Demand Side Management (DSM) Pilot Program Task Force 1991
- ComEd EMS Task Force 1983-1990
- Co-Founder Utility Economic Methods Group 1983
- ComEd Task Force to Comment on FASB11- Financial Lease Accounting 1981
- ComEd Dresden Decommission Task Force 1981
- American Nuclear Society Subcommittee on Nuclear and Fossil Economics 1979-1980
- ComEd Task Force to Execute the First Financial Sale and Lease-Back of Utility Assets 1979
- ComEd Coal Gasification Task Force 1972-1974
- ComEd / IBT Joint Pole Agreement Task Force 1972

TEACHING

Taught or participated in over 30 classes or expert panels.

- Presenter: "Frequency Control Research Needs," Carnegie Mellon University Transmission Conference, March 9 & 10, 2010.
- Presenter: "Integrating Renewable Resources into the Smart Grid," Electrical, Electronics and Computer Professional Delegation, Shanghi University of Engineering Science, October 30, 2009.
- Presenter: "Governor Deadband Issues," Measurement, Monitoring and Reliability Issues Associated with Primary Governing Frequency Response Task Force, IEEE PES General Meeting, Calgary, July 26, 2009.
- Presenter: "Integrating Renewable Resources," Carnegie Mellon University Transmission Conference, March 10 & 11, 2009.
- Panel Member: "Massive Electricity Storage: Fixing Renewable Power's Achilles Heel," AIChE General Meeting, New Orleans, April 7, 2008.

- Presenter: "Power System Stability/Instability," AIChE General Meeting, New Orleans, April 7, 2008.
- Presenter: "Frequency Deviation Reliability Risk Evaluation and Mitigation," Carnegie Mellon University Transmission Conference, March 11 & 12, 2008.
- Panel Member: "Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns," IEEE Summer PES Meeting, June 2007.
- Presenter: "Relating Primary Governing Frequency Response to Future Operating Reliability," IEEE Summer PES Meeting, June 2007.
- Presenter: "Frequency Response Standard Technical Issues," Carnegie Mellon University Transmission Conference, March 13 & 14, 2007.
- Presenter: "Frequency Response Standard Technical Issues," NERC Resources Subcommittee Meeting, November 15, 2006.
- Presenter: "Expanding the Requirements for Load Frequency Control", IEEE PES Summer Meeting, June 2006.
- Presenter: "Frequency Response and Frequency Responsive Reserve Measurement," Carnegie Mellon University Transmission Conference, January 2006.
- Presenter: "Completing the Market Design," CMU Transmission Conference, December 2004.
- Panel Member: "Black-start Panel", IEEE Summer PES Meeting, July 2002.
- Guest Lecturer for Illinois Institute of Technology, Electrical Engineering Graduate Seminar, November 2001.
- Guest Lecturer for University of Illinois, Electrical Engineering Graduate Seminar, April 2001.
- Panel Member: "Optimal Power Flow: A Business Case", IEEE Summer PES Meeting, July 1999.
- Session Chairman & Organizer, and Panel Member: "Commercializing Reliability", American Power Conference, April 1999.
- Guest Lecturer for University of Illinois, Electrical Engineering Graduate Seminar, April 1999.
- Presenter: "Status of NERC IOS ITF Draft Standards", MAIN Operating Committee Meeting, March 1998.
- Presenter: "Policy 1 vs. IOSITF", NERC Performance Subcommittee Meeting, January 1998.
- Panel Member: "EPRI Ancillary Services Workshop", Miami, FL, December 1997.
- Panel Member: "New Standards for NERC Control Area Performance", PICA97, Columbus, OH, May 1997.
- Session Chairman & Organizer, and Panel Member: "Ancillary Services", American Power Conference, April 1997.
- Panel Member: "NERC Control Performance Standard", IEEE PES Winter Meeting, New York, NY, February 1997.
- Session Chairman: "Artificial Intelligence for Load Forecasting", American Power Conference, April 1996.
- Panel Member: "Advances in Operation Scheduling", American Power Conference, April 1995.
- Guest Lecturer: "Management Decision Making Techniques", Economics Department, University of Chicago, Chicago, IL, 1982.
- Guest Lecturer: "Management Decision Making Techniques", Graduate School of Environmental Affairs, University of Wisconsin, Madison, WI, 1982.
- Guest Lecturer: "Management Decision Making Techniques", Nuclear Engineering Department, Missouri School of Engineering, Rolla, MO, 1981.
- Instructor: "Engineering Economics", Commonwealth Edison Co., 1977, 1978.
- Panel Member: "Recent Advances in Engineering Economics", IEEE PES, New York, NY, Winter 1978.

PUBLICATIONS

Author of over 100 technical papers and books.

1. **Illian, H.F.**, Developing a Frequency Model to Guide Reliability Decisions, Prepared for NERC Reliability Based Control Standard Drafting Team, April 5, 2010.
2. **Illian, H.F.**, Balancing and Frequency Control Issues and Research Needs, Carnegie Mellon University Transmission Conference, March 9, 2010.
3. **Illian, H.F.**, Calculating ACE Distribution Factors, Prepared for NERC Reliability Based Control Standard Drafting Team, August 24, 2009 revised February 25, 2010.
4. **Illian, H.F.**, Integrating Variable Renewable Energy Resources into the Smart Grid, Carnegie Mellon University Transmission Conference, March 10, 2009.
5. **Illian, H.F.**, Rebuttal Testimony of Howard F. Illian, PUC of Texas Docket No. 34738, Item No. 303, February 18, 2009.
6. **Illian, H.F.**, Frequency Deviation Reliability Risk Evaluation and Mitigation, Carnegie Mellon University Transmission Conference, March 11 & 12, 2008.
7. **Illian, H.F.**, Interconnections Frequency Response Research and Study, Prepared for CERTS and NERC Frequency Response Standard Drafting Team, September 30, 2007.

8. **Illian, H.F.**, Texas Interconnection Frequency Response Study, Prepared for NERC Frequency Response Standard Drafting Team, August 27, 2007.
9. **Illian, H.F.**, Western Interconnection Frequency Response Study, Prepared for NERC Frequency Response Standard Drafting Team, August 27, 2007.
10. **Illian, H.F.**, Texas Interconnection Sampling Analysis, Prepared for NERC Frequency Response Standard Drafting Team, August 23, 2007.
11. **Illian, H.F.**, Texas Interconnection Frequency Excursion Analysis, Prepared for NERC Frequency Response Standard Drafting Team, August 22, 2007.
12. **Illian, H.F.**, Texas Interconnection Frequency Data Year 2006, Prepared for NERC Resources Subcommittee, August 21, 2007.
13. **Illian, H. F.**, "Relating Primary Governing Frequency Response to Future Operating Reliability", IEEE PES Summer Meeting, June 2007.
14. IEEE Task Force Report, "Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns," Special Publication 07TP180, Final Report, May 2007.
15. **Illian, H.F.**, Eastern Interconnection Frequency Response Study, Prepared for NERC Frequency Response Standard Drafting Team, May 30, 2007.
16. **Illian, H.F.**, Western Interconnection Frequency Excursion Analysis, Prepared for NERC Frequency Response Standard Drafting Team, April 20, 2007.
17. **Illian, H.F.**, Eastern Interconnection Frequency Excursion Analysis, Prepared for NERC Frequency Response Standard Drafting Team, April 20, 2007.
18. **Illian, H.F.**, Western Interconnection Sampling Analysis, Prepared for NERC Frequency Response Standard Drafting Team, April 15, 2007.
19. **Illian, H.F.**, Eastern Interconnection Sampling Analysis, Prepared for NERC Frequency Response Standard Drafting Team, April 15, 2007.
20. **Illian, H. F.**, "Frequency Response Standard Technical Issues," Carnegie Mellon University Transmission Conference, March 13 & 14, 2007.
21. **Illian, H.F.**, Western Interconnection Frequency Data Year 2006, Prepared for NERC Resources Subcommittee, February 7, 2007.
22. **Illian, H.F.**, Western Interconnection Frequency Data Year 2005, Prepared for NERC Resources Subcommittee, February 7, 2007.
23. **Illian, H.F.**, Western Interconnection Frequency Data Year 2004, Prepared for NERC Resources Subcommittee, February 7, 2007.
24. **Illian, H.F.**, Eastern Interconnection Frequency Data Year 2006, Prepared for NERC Resources Subcommittee, February 7, 2007.
25. **Illian, H.F.**, Eastern Interconnection Frequency Data Year 2005, Prepared for NERC Resources Subcommittee, February 7, 2007.
26. **Illian, H.F.**, Eastern Interconnection Frequency Data Year 2004, Prepared for NERC Resources Subcommittee, February 7, 2007.
27. **Illian, H.F.**, Eastern Interconnection Frequency Data Year 2003, Prepared for NERC Resources Subcommittee, February 7, 2007.
28. **Illian, H.F.**, Eastern Interconnection Frequency Data Year 2002, Prepared for NERC Resources Subcommittee, February 7, 2007.
29. **Illian, H. F.**, "Discussion of Technical Issues Required to Implement a Frequency Response Standard", Prepared for the NERC Resources Subcommittee, November 15, 2006.
30. **Illian, H. F.**, "Expanding the Requirements for Load Frequency Control", IEEE PES Summer Meeting, June 2006.
31. **Illian, H.F.**, "Frequency Response and Frequency Responsive Reserve Measurement," Carnegie Mellon University Transmission Conference, January 11 & 12, 2006.
32. **Illian, H.F.**, What is the BAAL and What does it do?, Prepared for the NERC Balancing Resources and Demand Standard Drafting Team, May 28, 2005.
33. **Illian, H. F.**, "Comments on Notice of Proposed Rulemaking for Imbalance Provisions for Intermittent Resources Assessing the State of Wind Energy In Wholesale Electricity Markets", Prepared for the Federal Energy Regulatory Commission, Docket No. RM05-10-000 and Docket No. AD04-13-000, May 12, 2005.
34. **Illian, H. F.**, "Defining, Measuring and Valuing SCE Performance", Prepared for Garland Power and Light and the Texas MOD, January 20, 2005.
35. **Illian, H. F.**, "Defining, Measuring and Valuing Frequency Response", Prepared for Garland Power and Light and the Texas Nodal Team, January 1, 2005.
36. **Illian, H. F.**, "Completing the Market Design", Electricity Transmission in Deregulated Markets: Challenges, Opportunities, and Necessary R&D Agenda, Carnegie Mellon University, December 15 & 16, 2004.

37. **Illian, H. F.**, "Comparison of fixed BAAL to Frequency Dependent BAAL", Prepared for the NERC Balancing Resources and Demand Standard Drafting Team, October 6, 2004.
38. **Illian, H. F.**, "Conforming WECC Auto Time Error Correction to CPS1", Submitted to NAESB IIPTF, September 30, 2004.
39. **Illian, H. F.**, Blohm, R., "Marginal Energy Settlement of Inadvertent Interchange Using Native Prices", Submitted to NAESB IIPTF, June 22, 2004.
40. **Illian, H. F.**, "Assuring Balanced Settlement for Inadvertent Interchange", Submitted to NAESB IIPTF, June 18, 2004.
41. **Illian, H. F.**, "Setting the Balancing Authority ACE Limit (BAAL) for the NERC Abnormal Operations Measure (AOM)", Prepared for the NERC Balancing Resources and Demand Standard Drafting Team, March 28, 2004.
42. **Illian, H. F.**, "Native-Market-Pricing for Inadvertent Interchange", Submitted to NAESB IIPTF, March 25, 2004.
43. **Illian, H. F.**, "Meeting The Discrete Event Measure (DEM) Objectives With the Abnormal Operations Measure (AOM)", Prepared for the NERC Balancing Resources and Demand Standard Drafting Team, March 20, 2004.
44. **Illian, H. F.**, "Recent Inadvertent Interchange Energy Pricing Alternatives", Submitted to NAESB IIPTF, January 12, 2004.
45. **Illian, H. F.**, "Discrete Event Metric (DEM) Discussion", Prepared for the NERC Balancing Resources and Demand Standard Drafting Team, December 12, 2003.
46. **Illian, H. F.**, "NWPP Inadvertent Interchange Settlement Example", Submitted to NAESB IIPTF, December 1, 2003.
47. **Illian, H. F.**, "WECC Auto Time Error Correction Analysis", Submitted to NAESB IIPTF, November 24, 2003.
48. **Illian, H. F.**, Comments on Balancing Resources and Demand Standard, Submitted to NERC Balancing Resources and Demand SDT, August 13, 2003.
49. **Illian, H. F.**, "Locational-Pricing for Inadvertent Interchange", Submitted to NAESB IIPTF, June 24, 2003.
50. **Illian, H. F.**, "Inadvertent Interchange Energy Pricing Alternatives", Submitted to NAESB IIPTF, May 28, 2003.
51. **Illian, H. F.**, "Inadvertent Interchange Energy Price", Submitted to NAESB IIPTF, May 8, 2003.
52. **Illian, H. F.**, "Analysis of Alternative Time Error Correction", Prepared for NERC Resources Subcommittee & Reliability Coordinators Working Group, March 27, 2003.
53. **Illian, H. F.**, "Control Performance Measure (CPS2) Replacement Option Comments", Submitted to NERC, February 17, 2003.
54. **Illian, H. F.**, Blohm, R., "Abnormal operations Measure (AOM) as a Replacement for DCM", Submitted to NERC, February 17, 2003.
55. **Illian, H. F.**, "Energy Mark Discussion on the Nature of the Inadvertent Problem", Submitted to NAESB IIPTF, February 15, 2003.
56. **Illian, H. F.**, "Defining Good and Bad Inadvertent", January 2002, Submitted to NAESB IIPTF, February 15, 2003.
57. **Illian, H. F.**, "Comments on Balancing Resources and Demand SAR", Submitted to NERC, September 20, 2002.
58. **Illian, H. F.**, "Comments on Balancing Resources and Demand SAR", Submitted to NERC, June 25, 2002.
59. **Illian, H. F.**, "Frequency Control Study Progress Report to NERC Resources Subcommittee Addendum", Prepared for ERCOT, Submitted to NERC, July 16, 2002.
60. **Illian, H. F.**, "Relaxed Balanced Schedules – Impact on Frequency Control and Reliability with Recommendations", Prepared for ERCOT, June 26, 2002.
61. **Illian, H. F.**, "Frequency Control Study Progress Report to NERC Resources Subcommittee", Prepared for ERCOT, Submitted to NERC, June 10, 2002.
62. **Illian, H. F.**, "Frequency Control Data Advanced Analysis", Prepared for ERCOT, Submitted to NERC, June 10, 2002.
63. **Illian, H. F.**, "Black-start in a Market", IEEE PES Summer Meeting, July 2002.
64. **Illian, H. F.**, "Comments on Balancing Resources and Demand SAR", Submitted to NERC, March 18, 2002.
65. **Illian, H. F.**, "Defining Good and Bad Inadvertent", Submitted to NERC JIITF, September 28, 2001.
66. **Illian, H. F.**, "Comments on Policy 1", Submitted to NERC, August 3, 2001.
67. **Illian, H. F.**, "Comments on Policy 1", Submitted to NERC, November 25, 2000.
68. **Illian, H. F.**, "Comments on Independence of Balancing Authorities", Submitted to NERC, January 18, 2001.
69. **Illian, H. F.**, "Reliability Services in a Market", Ancillary Services Conference, Denver, September 2000.
70. **Illian, H. F.**, "Comments on Policy 10 Templates", Submitted to NERC, August 11, 2000.
71. **Illian, H. F.**, "Comments on Policy 10", Submitted to NERC, January 28, 2000.
72. **Illian, H. F.**, "Reliability Services in a Free Market Environment", Conference Proceedings, Power Quality '99, Chicago, Illinois, pp.292-306, November 1999.
73. **Illian, H. F.**, "Optimal Power Flow in a Market", IEEE PES Summer Meeting, July 1999.
74. **Illian, H. F.**, "Moving Reliability into the Market", Proceedings of the American Power Conference, April 1999.
75. **Illian, H. F.**, "Comments on Policy 10", Submitted to NERC, December 18, 1998.
76. Spicer, P. J., Galow, G., **Illian, H. F.**, Real-energy Supply-demand Balancing with Dynamic Schedules, Prepared for the NERC IOS ITF, September 21, 1998.

77. **Illian, H. F.**, Hoffman, S. P., "Enabling Market Managed Reliability", Proceedings of the American Power Conference, April 1998.
78. **Illian, H. F.**, Hoffman, S. P., "Real Energy Interconnected Operations Services", Proceedings of the American Power Conference, April 1998.
79. Wang, C., White, R. L., **Illian, H. F.**, Nauman, S. T., "Emergency Redispatch to Relieve Other Control Area Constraints", Proceedings of the American Power Conference, April 1998.
80. Hoffman, S. P., **Illian, H. F.**, "Study of Interconnection Frequency Characteristics", Proceedings of the American Power Conference, April 1998.
81. Rathsam, R. W., Hoffman, S. P., **Illian, H. F.**, "ComEd Implementation of NERC Control Performance Standard", Proceedings of the American Power Conference, April 1998.
82. Koehler, D. C., **Illian, H. F.**, "Statistical Approach For Solving Plant Modeling Problems", Proceedings of the American Power Conference, April 1998.
83. **Illian, H. F.**, "Real Energy Interconnected Operations Services Measurement Standards", Distributed to the NERC Interconnected Operations Services Implementation Task Force, March 1998.
84. **Illian, H. F.**, Hoffman, S. P., "Enabling Market Managed Reliability", Distributed to the NERC Interconnected Operations Services Implementation Task Force, March 1998.
85. **Illian, H. F.**, Hoffman, S. P., "Real Energy Interconnected Operations Services", Distributed to the NERC Interconnected Operations Services Implementation Task Force, March 1998.
86. **Illian, H. F.**, "How Should the Interconnected Operations Services Account for Frequency Response?" Distributed to the NERC Interconnected Operations Services Implementation Task Force, February 1998.
87. **Illian, H. F.**, "Description of Regulation & Load Following Interconnected Operations Service", Distributed to the NERC Interconnected Operations Services Implementation Task Force, January 1998.
88. **Illian, H. F.**, "Creating a Direct Frequency Control Interconnected Operations Service", Distributed to the NERC Interconnected Operations Services Implementation Task Force, November 1997.
89. **Illian, H. F.**, "Understanding the Single Meter Problem", Distributed to the NERC Interconnected Operations Services Implementation Task Force, October 1997.
90. **Illian, H. F.**, "Justification for a Frequency Response Interconnected Operations Service", Distributed to the NERC Interconnected Operations Services Implementation Task Force, October 1997.
91. Hoffman, S. P., **Illian, H. F.**, "Block Accounting for Interchange Transactions", Distributed to the NERC Interconnected Operations Subcommittee, August 1997.
92. Hoffman, S. P., **Illian, H. F.**, "Eastern Interconnection Frequency Study", Distributed to the NERC Performance Subcommittee, July 1997.
93. **Illian, H. F.**, Johnson, J. R., Krueger, D. P., "Positioning for Success as a GenCo", POWER-GEN Europe 97, Madrid, Spain, June 1997.
94. **Illian, H. F.**, Hoffman, S. P., Control Area Measurement Standards and Operating Margins, Comments to NERC IOSITF on Policy 10, April 14, 1997.
95. **Illian, H. F.**, Hoffman, S. P., "A Comprehensive and Integrated Mosaic of Energy and Ancillary Services", Proceedings of the American Power Conference, Vol. 59-II, April 1997.
96. Hoffman, S. P., **Illian, H. F.**, "ComEd and Eastern Interconnection Frequency Response Characteristic", Preliminary report presented to the NERC Performance Subcommittee, July 1994. Final report, "Frequency Response Characteristic Study for ComEd and the Eastern Interconnection", Proceedings of the American Power Conference, Vol. 59-II, April 1997.
97. **Illian, H. F.**, OATT Energy Imbalance Service Issues, Comments to NERC IOSITF on Policy 10, December 20, 1996.
98. **Illian, H. F.**, Missing Ancillary / Interconnected Operating Services, Comments to NERC IOSITF on Policy 10, October 24, 1996.
99. **Illian, H. F.**, Comments on Section 6. IOS Definitions and Interrelationships (Draft 3), Comments to NERC IOSITF on Policy 10, August 25, 1996.
100. Hoffman, S. P., **Illian, H. F.**, "Control Performance Standard Preliminary Results Using ComEd Data", Presented to NERC Performance Subcommittee, April 1996.
101. Hoffman, S. P., **Illian, H. F.**, Comments on the Recently Raised Issues Concerning the Control Performance Standard, Presented to NERC Performance Subcommittee, May 15, 1996.
102. Hoffman, S. P., **Illian, H. F.**, "Control Performance Criteria", Proceedings of the American Power Conference, Vol. 58, April 1996.
103. Aravandy, J. M., Lervy, J. G., **Illian, H. F.,** Matijasich, M., Stremel, J. P., Wells, W. M., White, R. L., Schainkler, Dr. R. B., "Speeding Convergence for Unit Commitment: An Application to Transmission Congestion Pricing", Proceedings of the American Power Conference, Vol. 58, April 1996.
104. **Illian, H. F.**, Comments on the CPS, Presented to NERC Performance Subcommittee, April 1, 1996.
105. **Illian, H. F.**, "Real Time Pricing", March 1996.

106. Hoffman, S. P., **Illian, H. F.**, "Decomposition of System Load into Base and Varying (AGC) Components using Fourier Analysis", Presented to NERC Performance Subcommittee, January 1996.
107. **Illian, H. F.**, Rathsam, R. W., "Preliminary Regulating Performance Value", ComEd, December 1995.
108. Hoffman, S. P., **Illian, H. F.**, Comments on the Selection of a New Control Performance Criteria, Presented to the NERC Performance Subcommittee, July 19, 1995.
109. Hoffman, S. P., **Illian, H. F.**, "Practical Implementation of the "D" Criteria", Presented to the NERC Performance Subcommittee, June 1995.
110. **Illian, H. F.**, White, R. L., "Discussion of the Higher Standards Required for Operating Models", Proceedings of the American Power Conference, Vol. 57, April 1995.
111. Hoffman, S. P., **Illian, H. F.**, "Fourier Analysis and Study of Interconnection Frequency Characteristics", Presented to NERC Performance Subcommittee, 1994.
112. Hoffman, S. P., **Illian, H. F.**, "Interconnection Frequency and Tie-Line Response to Load-Generation Imbalance", August 1993.
113. **Illian, H. F.**, "Preliminary Regulating Performance Value", ComEd, August 1993.
114. **Illian, H. F.**, "Regulating Performance Value", ComEd, April 1993.
115. **Illian, H. F.**, "Preliminary Unit EGC Control Performance Measurement", ComEd, May 1992.
116. **Illian, H. F.**, Dehnert, T. E., Fuerst, E. J., Kosak, J. J., Rathsam, R. W., Robertson, A. R., Sargent, C. E., AGC Task Force Report, ComEd, April 30, 1992.
117. Hansen, D. H., **Illian, H. F.**, Kilar, L. A., "Commonwealth Edison Designs Its Own SCADA/EMS System", Electrical World, Vol. 205, No. 5, May 1991.
118. **Illian, H. F.**, "The Revenue Requirements of Leasing", Utility Economic Methods Group Conference, Chicago, June 1983.
119. **Illian, H. F.**, "Correct Discount Rate", Winter IEEE Meeting, New York, N. Y., January 1978.
120. **Illian, H. F.**, "Capital Decision Making", Commonwealth Edison FACT Conference, Chicago, IL, May 1977.
121. Agosta, J., **Illian, H. F.**, Lundberg, R. M., Tranby, O. G., "Low BTU Gas for Power Station Emissions Control, Coal Processing Technology", American Institute of Chemical Engineers, 1974.
122. **Illian, H. F.**, "Clean Fuel From Coal", Commonwealth Edison Monthly Engineering Conference, January 1974; Commonwealth Edison Engineering Conference, Lake Lawn, WI, September 1973.
123. Agosta, J., **Illian, H. F.**, Lundberg, R. M., Tranby, O. G., Ahner, D., Sheldon, R. C, "The Future of Low BTU Gas in Power Generation", American Power Conference, Chicago, IL, April 1973.
124. Agosta, J., **Illian, H. F.**, Lundberg, R. M., Tranby, O. G., "Low BTU Gas for Power Station Emissions Control, Coal Processing Technology", Chemical Engineering Progress, Vol. 69, No. 3, March 1973.
125. Agosta, J., **Illian, H. F.**, Lundberg, R. M., Tranby, O. G., "Status of Low BTU Gas as a Strategy for Power Station Emissions Control", 65th Annual Meeting, American Institute of Chemical Engineers, New York, NY, November 1972.
126. **Illian, H. F.**, "The Remaining Spectrum (A Review of Industry Research)", Commonwealth Edison Monthly Engineering Conference, November 1972; Commonwealth Edison Engineering Conference, Lake Lawn, WI, September 1972.
127. **Illian, H. F.**, "Thermal Load Capabilities of Bare Copper and Aluminum Bus Bars", Commonwealth Edison Company, October 1969.
128. **Illian, H. F.**, "A Computer Program for Determining the Thermal Capabilities of Three Winding Transformers, Commonwealth Edison Company, June 1969.

ATTACHMENT B

NERC Frequency Response Initiative Objectives and Tasks

ATTACHMENT B
NERC FREQUENCY RESPONSE INITIATIVE OBJECTIVES AND TASKS (NEAR-TERM AND LONG-TERM)

Frequency Response Initiative Basic Objectives:

- Development of a clearer and more specific statement of frequency-related reliability factors, including better definitions for 'ownership' of responsibility for frequency response.
- Collection and provision of more granular data on and technical analyses of frequency-driven bulk power system events, including root cause analyses.
- Metrics and benchmarks to improve frequency response performance tracking.
- Increasing coordinated communication and outreach on the issue, to include webinars and NERC alerts, to share lessons learned.
- Focused discussion on and communication of emerging technical and technology issues, including frequency-related effects caused by renewable energy integration, 'smart grid' technology deployment, and new end-use technology.

Initial actions include:

Formalize the Frequency Response Working Group: NERC's Resources Subcommittee and Operating Committee have updated the charter for the Frequency Response Working Group and formalized this group as the supporting working group for this initiative.

This is expected to be completed by the end of April 2010.

Develop of Clear Definitions: Within the initiative, it will be crucial to develop and codify a set of meaningful and extremely descriptive terms. This will be the number one priority.

This is expected to be completed by the end of May 2010.

Data Request: The NERC Operating Committee, Frequency Response Working Group, and NERC staff will work with the Resources Subcommittee and Frequency Response Standards Drafting Team to implement a data collection effort from Balancing Authorities.

This is expected to be completed by May 31, 2010.

System Response Analysis: NERC engineering staff will work with the Resources Subcommittee and the Frequency Response Working Group to conduct a detailed analysis of frequency events to determine the factors influencing the various control responses from inception of the event to recovery.

This is expected to be completed by March 31, 2011.

Develop Consensus on Calculations of Frequency Response: NERC engineering staff will work with the Resources Subcommittee and the Frequency Response Working Group to agree on a single method of calculating frequency response.

This is expected to be completed by September 30, 2010.

Metrics and Benchmarking: NERC staff will work with the Reliability Metrics Working Group and Resources Subcommittee to track frequency performance on each interconnection to monitor trends and performance. We expect that an initial set of benchmarks will be developed for discussion and testing during 2010.

This is expected to be completed by March 31, 2011.

Communications and Outreach: NERC staff will work with industry experts to share lessons learned and highlight successful practices on a regular basis. NERC will develop a regular communications discipline with respect to frequency response issues.

This step has already begun and will be on-going.

Standards Development: The Frequency Response Standards Drafting Team (SDT) is considering a field test to support its Project 2007-12-Frequency Response. In addition, the SDT will work with the data collected through the data request and field trial to develop a Frequency Response Standard. The SDT will also work through the NERC Standards Committee to coordinate its efforts with interpretations requests regarding standards related to frequency performance.

This step has already begun. New and revised standards will be developed based on the outcomes of each step of the process. Should urgent actions be necessary to preserve bulk power system reliability, NERC will undertake these changes using the urgent action provisions of the reliability standards process.

The Frequency Response Initiative can be broken down into two distinctive time frames; short term and long term. The tasks to be completed in the respective time frames include:

Near-Term Tasks – Completed in Six Months

1. Issue a Recommendation and a survey in accordance with Section 810 of NERC's Rules of Procedure to in order to collect data to evaluate how frequency response should be addressed.
2. Based on the data received, analyze current and historical primary control frequency response performance and determine what factors influence that performance.
3. Based on the data received, analyze current and historical secondary control performance and determine what factors influence that performance.

4. Develop an automated method for determining frequency deviation events that should be used for Balancing Authorities to determine their primary control frequency Response.
5. Develop sustainable methods for automatically collecting, trending, and analyzing the various elements of frequency response and control.
6. Improve transient and mid-term dynamic models of generator primary frequency response.

Long-Term Tasks – Completed in One Year

1. Explore and analyze what are appropriate frequency response and control performance requirements to maintain system reliability.
2. Determine appropriate minimum Bias settings for use in AGC systems as part of an overall frequency response and control strategy.
3. Analyze current Inertial Response performance and determine what factors influence that performance.
4. Explore how displacement of inertial generation with electronically-coupled resources might influence Inertial Response.
5. Examine Primary Control Frequency Response characteristics of electronically-coupled resources and "smart grid" loads. Appropriate load and "generator" models must be developed to properly analyze their influence on system behavior in transient, post-transient, and mid-term stability.