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**BEFORE THE  
PROVINCE OF MANITOBA**

**NORTH AMERICAN ELECTRIC )  
RELIABILITY CORPORATION )**

**NOTICE OF FILING OF THE  
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION  
OF PROPOSED RELIABILITY STANDARD  
BAL-003-1 – FREQUENCY RESPONSE AND FREQUENCY BIAS SETTING**

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April 8, 2013

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BAL-003-1 – FREQUENCY RESPONSE AND FREQUENCY BIAS SETTING**

The North American Electric Reliability Corporation (“NERC”) hereby provides notice of the proposed Reliability Standard —BAL-003-1—Frequency Response and Frequency Bias Setting,<sup>1</sup> which was approved by the NERC Board of Trustees on February 7, 2013.

NERC is hereby providing notice of the proposed Reliability Standard, the associated definitions, implementation plan, Violation Risk Factors (“VRFs”) and Violation Severity Levels (“VSLs”), and retirement of the currently effective Reliability Standard and definition as detailed below. Specifically, NERC provides notice of the following:

- Proposed Reliability Standard BAL-003-1 Requirements R2, R3 and R4 included in **Exhibit B**, effective as provided in the Implementation Plan;
- Proposed Reliability Standard BAL-003-1 Requirement R1 included in **Exhibit B**, effective as provided in the Implementation Plan;
  - Retirement of BAL-003-0.1b at midnight of the day immediately prior to the effective date of Requirements R2, R3 and R4 of BAL-003-1.
- Three new definitions (Frequency Response Measure, Frequency Response Obligation and Frequency Response Sharing Group) and one revised definition (Frequency Bias Setting) effective as provided in the Implementation Plan;

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<sup>1</sup> Unless otherwise designated, all capitalized terms shall have the meaning set forth in the Glossary of Terms Used in NERC Reliability Standards, available here: [http://www.nerc.com/files/Glossary\\_of\\_Terms.pdf](http://www.nerc.com/files/Glossary_of_Terms.pdf).

- Retirement of the existing definition of Frequency Bias Setting at midnight of the day immediately prior to the effective date of Requirements R2, R3, and R4 of BAL-003-1.
- The implementation plan for the proposed BAL-003-1 Reliability Standard which is included in **Exhibit E**.

This notice presents the technical basis and purpose of the proposed Reliability Standard, a summary of the development proceedings conducted by NERC for proposed BAL-003-1 Reliability Standard, and a demonstration that the proposed Reliability Standard meets the criteria for approval of Reliability Standards.

The proposed standard achieves the specific reliability goal of ensuring that each of the Interconnections have sufficient Frequency Response<sup>2</sup> to guard against underfrequency load shedding (“UFLS”) due to an event in that Interconnection. The proposed Reliability Standard ensures that Balancing Authorities (“BAs”) provide Frequency Response necessary to ensure that frequency does not reach the point where coordinated UFLS relays are set to curtail loads. This is accomplished through a measurement methodology that ensures consistency across the industry for both Frequency Response and Frequency Bias Setting calculations.

## **I. EXECUTIVE SUMMARY**

Frequency Response, a measure of an Interconnection’s ability to stabilize frequency immediately following the sudden loss of generation or load, is a critical component to the reliable operation of the Bulk-Power System, particularly during disturbances and restoration.<sup>3</sup>

Power system operators manage or control frequency primarily through adjustments to the output

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<sup>2</sup> Frequency Response is defined in the Glossary of Terms Used in NERC Reliability Standards, as: “(Equipment) The ability of a system or elements of the system to react or respond to a change in system frequency. (System) The sum of the change in demand, plus the change in generation, divided by the change in frequency, expressed in megawatts per 0.1 Hertz (MW/0.1 Hz).”

<sup>3</sup> System frequency reflects the instantaneous balance between generation and load. Reliable operation of a power system depends on maintaining frequency within predetermined boundaries above and below a scheduled value, which is 60 Hertz (“Hz”) in North America.

of generators with the goal of restoring balance between generation and load. Failure to maintain frequency can disrupt the operation of equipment and initiate disconnection of power plant equipment to prevent them from being damaged, which could lead to wide-spread blackouts.

There is evidence of decline in Frequency Response in the three Interconnections over the past 10 years leading up to this standards project, but no confirmed reason for the apparent decline.<sup>4</sup> System planning and operations experts are anticipating new and different technical challenges, particularly in the reduction of system inertia through the displacement of conventional generation resources during light load periods. It is clear that maintaining adequate Frequency Response for Bulk-Power System reliability is becoming more important and complex. While the decline in Frequency Response has lessened, it is important that the industry understands the growing complexities of frequency control and is ready with comprehensive strategies to stay ahead of any potential problems, and the proposed BAL-003-1 Reliability Standard is an important part of that strategy.

The proposed Reliability Standard, BAL-003-1, sets a minimum Frequency Response Obligation for each BA, provides a uniform calculation of Frequency Response and Frequency Bias Settings that transition to values closer to natural Frequency Response, and encourages coordinated Automatic Generation Control (“AGC”) operation. Frequency Response must be evaluated on an interconnection-wide basis in order to establish the Frequency Response responsibilities for an individual BA.<sup>5</sup>

Proposed Reliability Standard BAL-003-1 is applicable to Balancing Authorities and to the newly proposed term -- Frequency Response Sharing Groups, and consists of four Requirements and Attachment A: *BAL-003-1 Frequency Response and Frequency Bias Setting*

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<sup>4</sup> See **Exhibit F**, Frequency Response Initiative Report at p. 22.

<sup>5</sup> The amount of Frequency Response required on an interconnection-wide basis is known as the Interconnection Frequency Response Obligation (“IFRO”).

*Standard Supporting Document.* Attachment A (appended to the proposed standard) is a supporting document for proposed Reliability Standard BAL-003-1 that discusses the process the ERO will follow to validate the Balancing Authority's FRS Form 1 data and publish the official Frequency Bias Settings. FRS Form 1 provides the guidance as to how to account for and measure Frequency Response. FRS Form 1, and the underlying data retained by the Balancing Authority, will be used for measuring whether sufficient Frequency Response was provided.

*A Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard* and the *Frequency Response Standard Background Document* are submitted for informational purposes.<sup>6</sup> The *Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard* outlines how the ERO will conduct a transparent process to annually identify a list of frequency events to be used by BAs to calculate their Frequency Response to determine whether the BA met its Frequency Response Obligation and an appropriate fixed Frequency Bias Setting.<sup>7</sup>

A detailed explanation of the development, testing and implementation of proposed Reliability Standard BAL-003-1 is provided in the *Frequency Response Standard Background Document*. This document will be maintained and updated by the ERO and the NERC Resources Subcommittee (a division of the NERC Operating Committee) on a going-forward basis and will be used as a reference and training resource.

In conjunction with the proposed Reliability Standard, the following definitions are proposed for inclusion in the NERC Glossary of Terms Used in Reliability Standards:

- Frequency Response Measure;

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<sup>6</sup> NERC is not seeking approval of these documents.

<sup>7</sup> The *Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard* is submitted for informational purposes. Any future approved revisions to the Procedure will also be filed with the applicable governmental authorities for informational purposes.

- Frequency Response Obligation;
- Frequency Bias Setting; and
- Frequency Response Sharing Group.

Collectively, the proposed BAL-003-1 Reliability Standard and the proposed definitions perform a vital reliability function by ensuring that there is sufficient Frequency Response from BAs to maintain Interconnection frequency within predefined bounds and by providing consistent methods for measuring Frequency Response and determining the Frequency Bias Setting. The proposed Reliability Standard was developed by a standard drafting team that consists of some of the foremost experts in the field of Frequency Response, as explained in **Exhibit L**.

## **II. NOTICES AND COMMUNICATIONS**

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

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### **III. BACKGROUND**

#### **A. NERC Reliability Standards Development Procedure**

The proposed Reliability Standard was developed in an open and fair manner and in accordance with the Reliability Standard development process. NERC develops Reliability Standards in accordance with Section 300 (Reliability Standards Development) of its Rules of Procedure and the NERC Standard Processes Manual.<sup>8</sup> NERC's proposed rules provide for reasonable notice and opportunity for public comment, due process, openness, and a balance of interests in developing Reliability Standards and thus satisfies certain of the criteria for approving Reliability Standards. The development process is open to any person or entity with a legitimate interest in the reliability of the Bulk-Power System. NERC considers the comments of all stakeholders, and a vote of stakeholders and the NERC Board of Trustees is required to approve a Reliability Standard before the Reliability Standard is submitted to the applicable governmental authorities for approval.

#### **B. Procedural Background**

In Order No. 693, issued on March 16, 2007, the Federal Energy Regulatory Commission ("FERC") approved the NERC Resource and Demand Balancing Reliability Standards, including BAL-003-0, which addresses Frequency Response and Frequency Bias. Order No. 693 (at P 375) directed NERC to:

develop a modification to BAL-003-0 through the Reliability Standards development process that: (1) includes Levels of Non-Compliance; (2) determines the appropriate periodicity of frequency response surveys necessary to ensure that Requirement R2 and other requirements of the Reliability Standard are being met, and to modify Measure M1 based on that determination and (3) defines the necessary amount of Frequency Response needed for Reliable Operation for each

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<sup>8</sup> The NERC Rules of Procedure are available here: <http://www.nerc.com/page.php?cid=1%7C8%7C169>. The current NERC Standard Processes Manual is available here: [http://www.nerc.com/files/Appendix\\_3A\\_StandardsProcessesManual\\_20120131.pdf](http://www.nerc.com/files/Appendix_3A_StandardsProcessesManual_20120131.pdf).



balancing authority with methods of obtaining and measuring that the frequency response is achieved.

On March 18, 2010, FERC issued an Order Setting Deadline for Compliance<sup>9</sup> (“March 18 Order”) with directives from Order No. 693 concerning Reliability Standard BAL-003-0–Frequency Response and Bias. The March 18 Order directed NERC to submit a modification to BAL-003-0 responsive to the directive in Order No. 693 within six months from the date of the issuance of the order.

NERC filed a request for clarification and rehearing of the March 18 Order on April 19, 2010, and explained that compliance with a six-month deadline was impossible given the highly technical issues related to Frequency Response and the necessity of conducting studies and analyses.<sup>10</sup>

On May 13, 2010, FERC issued an Order Granting Rehearing for Further Consideration and Scheduling Technical Conference (“Rehearing Order”).<sup>11</sup> Specifically, the Rehearing Order granted rehearing for the limited purpose of further consideration, and scheduled a technical conference to discuss technical issues identified in the development of a Frequency Response requirement in BAL-003-0. In the Rehearing Order, FERC directed NERC to file, within 30 days after the technical conference, a proposed schedule that included the analyses needed to develop a Frequency Response requirement, and firm deadlines for completing those analyses. In the Rehearing Order, FERC deferred the six-month compliance deadline included in the March 18 Order.<sup>12</sup>

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<sup>9</sup> *Mandatory Reliability Standards for the Bulk Power System, Order Setting Deadline for Compliance*, 130 FERC ¶ 61,218 (2010)(“March 18 Order”).

<sup>10</sup> *Request of the North American Electric Reliability Corporation for Clarification and Rehearing of the Order Setting Deadline for Compliance*, Docket No. RM06-16-010 (April 19, 2010) at pp. 4-7.

<sup>11</sup> *Mandatory Reliability Standards for the Bulk Power System, Order Granting Rehearing for Further Consideration and Scheduling Technical Conference*, 131 FERC ¶ 61,136 (2010).

<sup>12</sup> *Id.* at P 2.

On October 14, 2010, as directed in the Rehearing Order, NERC filed comments following the September 23 Frequency Response technical conference.<sup>13</sup> In this filing, NERC committed to filing a proposed timeline for development of a Reliability Standard addressing FERC's directives by October 25, 2010. NERC submitted an action plan and estimated timeline on October 25, 2010 that provided milestones for the completion of the project by May 2012. NERC continuously noted that significant rigorous technical analysis is necessary to determine the Frequency Response requirement needed for each Interconnection without also placing significant and unnecessary cost burdens for over-installing frequency responsive control systems.<sup>14</sup> On December 16, 2010, FERC accepted NERC's anticipated May 2012 target date.<sup>15</sup>

On March 30, 2012, NERC filed a motion for an extension of time to submit a revised BAL-003 Reliability Standard. In an *Order on Motion for an Extension of Time and Setting Compliance Schedule*, FERC established a deadline for completion of research and analysis and a deadline of May 31, 2013 for submission of a revised BAL-003 Reliability Standard.<sup>16</sup> In compliance, NERC submitted quarterly reports on October 31, 2012 and January 23, 2013. The instant filing is submitted prior to the May 31, 2013 deadline in compliance with FERC's directive.

### **C. Frequency Response and the Frequency Response Initiative**

Provided below is a brief explanation of Frequency Response and NERC's Frequency Response Initiative.

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<sup>13</sup> *Comments Of The North American Electric Reliability Corporation Following September 23 Frequency Response Technical Conference*, Docket Nos. RM06-16-010 and RM06-16-011 (October 14, 2010).

<sup>14</sup> *See Request of the North American Electric Reliability Corporation for Clarification and Rehearing of the Order Setting Deadline for Compliance*, Docket No. RM06-16-000 (April 19, 2010) at pp. 3-4.

<sup>15</sup> *Mandatory Reliability Standards for the Bulk-Power System*, 133 FERC ¶ 61,212 (2010).

<sup>16</sup> *Mandatory Reliability Standards for the Bulk-Power System*, 139 FERC ¶ 61,097 (2012).

## 1. Frequency Response: An Overview

Primary frequency control involves the autonomous, automatic, and rapid action of a generator, or other resource, to change its output (within seconds) to oppose large changes in frequency. The primary frequency control provided by an individual generator is commonly known as Frequency Response. Measurement of primary Frequency Response on an individual resource or load basis requires analysis of energy amounts that are often small and difficult to measure using installed metering. The ability of a power system to withstand a sudden loss of generation depends on the presence and adequacy of operating reserves that are on-line and capable of providing primary frequency control.

Secondary frequency control (also known as Automatic Generating Control (“AGC”)) comes from either manual or automated dispatch from a centralized control system and manages the allocation of loading among the available power plants. Secondary frequency control follows primary frequency control and takes place in the time scale of minutes. A task of secondary frequency control is to ensure that the system is always positioned so that the required amount of primary frequency control action will be available if needed. Tertiary generation control adjusts the loading of turbines through operator dispatch and is dominant in the range of minutes to hours after a frequency excursion.

Frequency Bias is a term used in AGC to prevent withdrawal of generator primary control action following a disturbance as long as the frequency is off its nominal value. Frequency Bias is *not* the same as Frequency Response. Frequency Bias is a secondary control setting of the AGC system, not a primary control parameter. Changes in Frequency Bias of a Balancing Authority *do not* change Frequency Response. A detailed explanation of Frequency Response is provided in the *Frequency Response Background Document*, included as **Exhibit D**.

## 2. Frequency Response Initiative

To comprehensively address the issues related to Frequency Response, NERC launched the Frequency Response Initiative in 2010. In addition to coordinating the myriad of efforts underway in standards development and performance analysis, the Initiative includes performing in-depth analysis of interconnection-wide Frequency Response to achieve a better understanding of the factors influencing frequency performance across North America.<sup>17</sup> Basic objectives of the Frequency Response Initiative include:

- 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 Frequency Response 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 and to share lessons learned; and
- focused discussion on communication of emerging technology issues, including frequency-related effects caused by renewable energy integration, smart grid technology deployment, and new end-use technology.

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<sup>17</sup> The Electric Reliability Council of Texas (“ERCOT”) region is often held up as a model with respect to the issue of Frequency Response because significant improvements in Frequency Response have been achieved in ERCOT. NERC has reviewed the actions taken by ERCOT to address control settings within ERCOT and the responsiveness of generation to a recent frequency event due to the tripping of a generator and has evaluated these lessons learned in developing the proposed Reliability Standard. However, there are several significant differences with respect to the ERCOT system that limit the application of these lessons on a North American-wide basis. The ERCOT grid is separated electrically from the rest of North America. Two DC (direct current) ties link the ERCOT with Southwest Power Pool to the north and east. ERCOT schedules and centrally dispatches its grid within a single control area, ensures transmission reliability and wholesale open access, and manages financial settlement in the wholesale power market. It also administers the Texas competitive retail market, including customer switching. The ERCOT grid covers 75% of Texas land and serves 85% of the Texas load. *See* [http://www1.eere.energy.gov/analysis/pdfs/demand\\_response\\_in\\_the\\_ercot\\_markets\\_mark\\_patterson.pdf](http://www1.eere.energy.gov/analysis/pdfs/demand_response_in_the_ercot_markets_mark_patterson.pdf). In contrast, the Eastern Interconnection covers approximately 3.5 million square miles and includes the provinces of Saskatchewan, Manitoba, Ontario, Quebec and the Maritimes provinces in Canada, and all or portions of the contiguous 39 U.S. states (and the District of Columbia) east of the Western Interconnection. Due to these physical and regional variations that directly impact Frequency Response, the lessons learned in ERCOT cannot be universally applied.

The Frequency Response Initiative Report, included as **Exhibit F**, was issued in support of Project 2007-12 with seventeen recommendations. A discussion of the status of these recommendations is provided as **Exhibit G**. A draft supplemental report regarding the IFRO Simulations is provided as **Exhibit H**.

#### **IV. JUSTIFICATION OF PROPOSED DEFINITIONS AND RELIABILITY STANDARD**

Provided below is the following: (A) a description of the proposed definitions, (B) justification for the proposed BAL-003-1 Reliability Standard on a Requirement by Requirement basis, and (C) an explanation of the enforceability of the proposed Standard.

##### **A. Proposed Definitions**

Three new definitions are proposed for inclusion in the NERC Glossary of Terms Used in Reliability Standards:

- **Frequency Response Measure (FRM):** The median of all the Frequency Response observations reported annually by Balancing Authorities or Frequency Response Sharing Groups for frequency events specified by the ERO. This will be calculated as MW/0.1Hz.
- **Frequency Response Obligation (FRO):** The Balancing Authority's share of the required Frequency Response needed for the reliable operation of an Interconnection. This will be calculated as MW/0.1Hz.
- **Frequency Response Sharing Group (FRSG):** A group whose members consist of two or more Balancing Authorities that collectively maintain, allocate, and supply operating resources required to jointly meet the sum of the Frequency Response Obligations of its members.

The proposed BAL-003-1 Reliability Standard allows Balancing Authorities to cooperatively form Frequency Response Sharing Groups as a means to jointly meet the obligations of the standard. There is no obligation to form or be part of a Frequency Response Sharing Group.

The members of the Frequency Response Sharing Group would determine how to allocate penalties/violations among its members. The creation of Frequency Response Sharing Groups is one of the ways the standard drafting team addressed FERC’s directive to provide methods for obtaining Frequency Response.<sup>18</sup>

One revised definition is proposed for inclusion in the NERC Glossary of Terms Used in Reliability Standards:

- **Frequency Bias Setting:** A number, either fixed or variable, usually expressed in MW/0.1 Hz, included in a Balancing Authority’s Area Control Error equation to account for the Balancing Authority’s inverse Frequency Response contribution to the Interconnection, and discourage response withdrawal through secondary control systems.

The proposed revised definition for “Frequency Bias Setting” is incorporated in the following NERC approved Standards:

- § BAL-001-0.1a Real Power Balancing Control Performance
- § BAL-004-0 Time Error Correction
- § BAL-004-1 Time Error Correction
- § BAL-005-0.1b Automatic Generation Control

These proposed new and revised definitions are used throughout the Requirements of proposed Reliability Standard BAL-003-1.

### **B. Proposed Reliability Standard, BAL-003-1**

Proposed Reliability Standard BAL-003-1 consists of four Requirements and is applicable to Balancing Authorities and to the newly proposed term -- Frequency Response Sharing Groups. BAL-003-1 offers significant improvements for reliability over the existing

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<sup>18</sup> Order No. 693 at P 375.

BAL-003-0.b Reliability Standard.<sup>19</sup> BAL-003-1 defines the minimum Frequency Response needed for reliable operation and methods for obtaining the Frequency Response.<sup>20</sup>

BAL-003 is part of the Resource and Demand Balancing (“BAL”) body of Reliability Standards. Collectively, the six BAL Reliability Standards address balancing resources and demand to maintain interconnection frequency within prescribed limits. As FERC noted in Order No. 693, the purpose of BAL-003-0 is to “ensure that a balancing authority’s frequency bias setting is accurately calculated to match its actual frequency response.”<sup>21</sup>

The purpose of proposed Reliability Standard BAL-003-1 is to not only ensure that a Balancing Authority’s Frequency Bias Setting is accurately calculated to match its actual Frequency Response, but also to provide consistent methods for measuring Frequency Response and determining the Frequency Bias Setting. FERC stated in Order No. 693 that the minimum Frequency Response needed for reliable operation should be defined and methods for obtaining the Frequency Response identified (at P 372). BAL-003-1 satisfies these directives and is a significant improvement over the currently effective BAL-003-0.1b Reliability Standard.

### **1. BAL-003-1, Requirement R1**

**R1.** Each Frequency Response Sharing Group (FRSG) or Balancing Authority that is not a member of a FRSG shall achieve an annual Frequency Response Measure (FRM) (as calculated and reported in accordance with Attachment A) that is equal to or more negative than its Frequency Response Obligation (FRO) to ensure that sufficient Frequency Response is provided by each FRSG or BA that is not a member of a FRSG to maintain Interconnection Frequency Response equal to or more negative than the Interconnection Frequency Response Obligation. [*Risk Factor: Medium*] [*Time Horizon: Real-time Operations*]

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<sup>19</sup> A mapping document illustrating how the Requirements of the existing BAL-003 standard have been either incorporated into or superseded by the proposed BAL-003-1 Reliability Standard is provided in **Exhibit K**.

<sup>20</sup> The standard drafting team identified several methods of obtaining frequency response, including: Regulation Services; contractual services; through a tariff; from generators through an interconnection agreement; and contract with an internal resource or loads. See **Exhibit D**.

<sup>21</sup> Order No. 693 at P 357 (internal citations omitted).

The primary objectives of Requirement R1 are as follows:

- (1) Determine whether a Balancing Authority has sufficient Frequency Response for reliable operations.
- (2) Provide the feeder information needed to calculate Control Performance Standard limits and Frequency Bias Settings.

Requirement R1 achieves the first objective via FRS Form 1 and the process in Attachment A that provides the method for determining the Interconnections' necessary amount of Frequency Response and allocating it to the Balancing Authorities.

Each Frequency Response Sharing Group or Balancing Authority that is not a member of a Frequency Response Sharing Group shall have evidence such as dated data plus documented formula in either hardcopy or electronic format that it achieved an annual FRM (in accordance with the methods specified by the ERO in Attachment A with data from FRS Form 1 reported to the ERO as specified in Attachment A) that is equal to or more negative than its FRO to demonstrate compliance with Requirement R1.

Consistent with the findings of the Frequency Response Initiative Report, BAL-003-1 does not judge compliance of Frequency Response performance on an event-by-event basis. Analysis of data submitted by BAs during the field trial indicated that a single-event based compliance measure is unsuitable for compliance evaluation when based on data that has the large degree of variability demonstrated by the field trial. Analysis of data submitted by the BAs during the field trial confirms that the sample size selected (a minimum of 20–25 frequency events) is sufficient for stable results and alleviates the problem associated with outliers in the measurement of BA Frequency Response performance.<sup>22</sup>

Requirement R1 and Attachment A satisfy FERC's directive in Order No. 693 (at P 375) to "determine the appropriate periodicity of frequency response surveys necessary to ensure that

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<sup>22</sup> See **Exhibit F**, Frequency Response Initiative Report at p. 72.



Requirement R2 and other requirements of the Reliability Standard are met...” The standard drafting team determined that an annual assessment would provide a sufficient sample size of events of proper magnitudes to calculate Frequency Response with reasonable accuracy.<sup>23</sup>

The standard drafting team’s proposed methodology for determining each Interconnection’s and BA’s obligation for obtaining the necessary amount of Frequency Response is set forth in Attachment A. The contingency protection criterion is the largest reasonably expected contingency in the Interconnection and can be based on the largest observed credible contingency in the previous ten years or the largest Category C event for the Interconnection. Attachment A presents the base obligation by the Interconnection and adds a reliability margin. The reliability margin addresses the difference between Points B and C and accounts for other relevant variables as well. For multiple BA interconnections, the Frequency Response Obligation is allocated to BAs based on size. This allocation is based on the formula set forth in Attachment A to the proposed Reliability Standard.

FRS Form 1 and the underlying data retained by the BA will be used for measuring whether Frequency Response was provided. FRS Form 1 provides the guidance as to how to account for and measure Frequency Response. Therefore, the proposed Reliability Standard defines the necessary amount of Frequency Response needed for reliable operation for each BA with methods of obtaining and measuring that Frequency Response is achieved, in compliance with Order No. 693.

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<sup>23</sup> Note, the Frequency Bias Setting process is an annual cycle and covers all seasons (there is variability among the seasons).

## 2. Median as the Measure of Balancing Authority Performance

The standard drafting team evaluated different approaches for “averaging” individual event observations to compute a technically sound estimate of Frequency Response Measure, including the median and linear regression.

The MW contribution for a single BA in a multi-BA Interconnection is small compared to the minute to minute changes in load, interchange and generation. For example, a 3000 MW BA in the Eastern Interconnection may only be called on to contribute 10MW for the loss of a 1000 MW. The 10 MW of governor and load response may easily be masked by a coincident change in load. In general, statisticians use the median as the best measure of central tendency when a population has outliers. Based on the analyses performed thus far, the standard drafting team believes that the median’s superior resiliency to this type of data quality problem makes it the best aggregation technique at this time. However, the standard drafting team sees merit and promise in future research with sample filtering combined with a technique such as linear regression. When compared with the mean, linear regression shows superior performance with respect to the elimination of noise because the measured data is weighted by the size of the frequency change associated with the event.<sup>24</sup> Since the noise is independent from frequency change, the greater weighting on larger events provides a superior technique for reducing the effect of noise on the results. The standard drafting team acknowledges that linear regression should be re-evaluated for use in the BAL-003 Reliability Standard once more experience is gained with data collected.<sup>25</sup>

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<sup>24</sup> The term “noise” refers to factors that can influence data and produce outliers such as concurrent operating phenomena (discussed in the Background Document, **Exhibit D**), transient tie line flows for nearby contingencies, data acquisition time skew in tie line data measurements and time skew and data compression issues.

<sup>25</sup> As noted in **Exhibit G**, NERC and the Frequency Response Working Group will include an update of the linear regression analysis from the Frequency Response Initiative Report during the annual review process (described in Recommendation 14).

### 3. BAL-003-1, Requirement R2

**R2.** Each Balancing Authority that is a member of a multiple Balancing Authority Interconnection and is not receiving Overlap Regulation Service and uses a fixed Frequency Bias Setting shall implement the Frequency Bias Setting determined in accordance with Attachment A, as validated by the ERO, into its Area Control Error (ACE) calculation during the implementation period specified by the ERO and shall use this Frequency Bias Setting until directed to change by the ERO. [*Risk Factor: Medium*][*Time Horizon: Operations Planning*]

Attachment A is incorporated by reference into Requirement R2.<sup>26</sup> Attachment A details the process that the ERO will undertake to validate the BA's FRS Form 1 data. Frequency Bias Settings generally change very little from year-to-year.

The current BAL-003 Reliability Standard requires a minimum Frequency Bias Setting equal in absolute value to one percent of the BA's estimated yearly demand (or maximum generation level if native load is not served) per tenth of a Hz change in frequency. For most BA's this calculated amount of Frequency Bias is significantly greater in absolute value than their actual Frequency Response characteristic (which represents an over-bias condition) resulting in over-control.

The ideal system control state exists when the Frequency Bias Setting of the BA exactly matches the Frequency Response characteristics of the BA. Setting the Frequency Bias to better approximate the BA natural response characteristic will improve the quality of ACE control and general AGC System control response. The *Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard* is intended to bring the BA's Frequency Bias Setting closer to their natural Frequency Response characteristic.

The proposed annual process is as follows:

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<sup>26</sup> Any future modifications to Attachment A will be developed through the standard development process in accordance with the NERC Standard Processes Manual.

1. The ERO posts the official list of frequency events to be used for BAL-003-1 in early December. The FRS Form 1 for each Interconnection will be posted shortly thereafter.
2. The Balancing Authority submits its revised annual Frequency Bias Setting value to NERC by January 10.
3. The ERO and the Resources Subcommittee validate Frequency Bias Setting values, perform error checking, and calculate, validate, and update CPS2 L10 values. This data collection and validation process can take as long as two months.
4. Once the L10 and Frequency Bias Setting values are validated, the ERO posts the values for the upcoming year and also informs the Balancing Authorities of the date on which to implement revised Frequency Bias Setting values. Implementation typically would be on or about March 1st of each year.

The ERO, in coordination with the regions of each Interconnection, will annually review Frequency Bias Setting data submitted by BAs.

#### **4. BAL-003-1, Requirement R3**

**R3.** Each Balancing Authority that is a member of a multiple Balancing Authority Interconnection and is not receiving Overlap Regulation Service and is utilizing a variable Frequency Bias Setting shall maintain a Frequency Bias Setting that is: *[Risk Factor: Medium ] [Time Horizon: Operations Planning]*

**3.1** Less than zero at all times, and

**3.2** Equal to or more negative than its Frequency Response Obligation when Frequency varies from 60 Hz by more than +/- 0.036 Hz.

In multiple BA interconnections, the Frequency Bias Setting should be coordinated among all BAs in the interconnection. When there is a minimum Frequency Bias Setting requirement, it should apply for all BAs. However, BAs using a variable Frequency Bias Setting may have non-linearity in their actual response for a number of reasons including the dead-bands implemented on their generator governors. The measurement to ensure that these BAs are conforming to the interconnection minimum is adjusted to remove the dead-band range from the calculated average Frequency Bias Setting actually used. For BAs using variable bias, FRS Form 1 has a data entry location for the previous year's average monthly Bias. The BA and the

ERO can compare this value to the previous year's Frequency Bias Setting minimum to ensure Requirement R3 has been met.

On single BA Interconnections, there is no need to coordinate the Frequency Bias Setting with other BAs. This eliminates the need to maintain a minimum Frequency Bias Setting for any reason other than meeting the reliability requirement as specified by the Frequency Response Obligation.

#### 5. BAL-003-1, Requirement R4

**R4.** Each Balancing Authority that is performing Overlap Regulation Service shall modify its Frequency Bias Setting in its ACE calculation, in order to represent the Frequency Bias Setting for the combined Balancing Authority Area, to be equivalent to either: [*Risk Factor: Medium*] [*Time Horizon: Operations Planning*]

- The sum of the Frequency Bias Settings as shown on FRS Form 1 and FRS Form 2 for the participating Balancing Authorities as validated by the ERO, or
- The Frequency Bias Setting shown on FRS Form 1 and FRS Form 2 for the entirety of the participating Balancing Authorities' Areas.

Requirement R4 reflects the principles first established by NERC Policy 1<sup>27</sup> and is similar to Requirement R6 in the existing BAL-003.1b Reliability Standard.<sup>28</sup> Overlap Regulation Service is a method of providing regulation service in which the BA providing the regulation service incorporates another BA's actual interchange, frequency response, and schedules into the providing BA's AGC/ACE equation. A BA that is *providing* Overlap Regulation will report the sum of the Bias Settings in its FRS Form 1. A BA that is *receiving* Overlap Regulation Service has an ACE and Frequency Bias Setting equal to zero.

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<sup>27</sup> Prior to the establishment of mandatory and enforceable Reliability Standards, NERC Operating Policies existed, including Policy 1 - Generation Control and Performance.

<sup>28</sup> Reliability Standard BAL-003.1b, **R6.** A Balancing Authority that is performing Overlap Regulation Service shall increase its Frequency Bias Setting to match the frequency response of the entire area being controlled. A Balancing Authority shall not change its Frequency Bias Setting when performing Supplemental Regulation Service.

### C. Enforceability of the Proposed Reliability Standard

The Proposed BAL-003-1 Reliability Standard includes VRFs and VSLs which is an equally effective and efficient method of satisfying FERC’s directive in Order No. 693 (at P 375) to “include[] Levels of Non-Compliance...” The proposed BAL-003-1 Reliability Standard contains Measures that support each Requirement by clearly identifying what is required and how the Requirement will be enforced. The VSLs provide further guidance on the way that NERC will enforce the Requirements of the proposed Reliability Standard. The VRFs and VSLs for the proposed BAL-003-1 Reliability Standard comport with NERC guidelines related to their assignment. For a detailed review of the VRFs, the VSLs, and the analysis of how the VRFs and VSLs were determined using these guidelines, see **Exhibit J**.

Respectfully submitted,

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**April 8, 2013**

## **EXHIBIT A – Criteria for Approval of Reliability Standards**

### **Criteria for Approval of Reliability Standards**

**1. Proposed Reliability Standards must be designed to achieve a specified reliability goal and must contain a technically sound means to achieve that goal.**

The proposed standard achieves the specific reliability goal of ensuring that the Interconnections have sufficient Frequency Response to guard against underfrequency load shedding (“UFLS”) due to an event in that Interconnection. The proposed Reliability Standard ensures that Balancing Authorities provide Frequency Response necessary to ensure that the frequency does not reach the point where coordinated UFLS relays are set to curtail loads. This is accomplished through a measurement methodology that ensures consistency across the industry for both frequency response and Frequency Bias Setting calculations.

**2. Proposed Reliability Standards must be applicable only to users, owners and operators of the bulk power system, and must be clear and unambiguous as to what is required and who is required to comply.**

The proposed revisions to this Reliability Standard apply to Balancing Authorities and Frequency Response Sharing Groups and are clear and unambiguous as to what is required and who is required to comply. The requirements clearly state who is required to comply with the standard. In addition, the standard includes an Attachment A and a Background Document. Attachment A provides the methodology used to determine the metrics for compliance. The Background Document, included as **Exhibit D**, provides information describing how the requirements and metrics were determined and details what the requirements are designed to accomplish.

**3. A proposed Reliability Standard must include clear and understandable consequences and a range of penalties (monetary and/or non-monetary) for a violation.**

## **EXHIBIT A – Criteria for Approval of Reliability Standards**

The VRFs and VSLs for the proposed standard comport with NERC guidelines related to their assignment. The assignment of the severity level for each VSL is consistent with the corresponding Requirement and the VSLs should ensure uniformity and consistency in the determination of penalties. The VSLs do not use any ambiguous terminology, thereby supporting uniformity and consistency in the determination of similar penalties for similar violations. For these reasons, the proposed Reliability Standard includes clear and understandable consequences.

### **4. A proposed Reliability Standard must identify clear and objective criterion or measure for compliance, so that it can be enforced in a consistent and non-preferential manner.**

The proposed Reliability Standard contains measures that support each requirement by clearly identifying what is required and how the requirement will be enforced. These measures help provide clarity regarding how the requirements will be enforced, and ensure that the requirements will be enforced in a clear, consistent, and non-preferential manner and without prejudice to any party.

### **5. Proposed Reliability Standards should achieve a reliability goal effectively and efficiently — but do not necessarily have to reflect “best practices” without regard to implementation cost or historical regional infrastructure design.**

The proposed Reliability Standard achieves its reliability goals effectively and efficiently. The proposed Reliability Standard was developed by the Standard Drafting Team after NERC staff and the Standard Drafting team completed significant studies related to Frequency Response. These studies helped determine the level of response needed in each of the four Interconnections that are subject to compliance with NERC standards. Based on the results of these studies, the proposed Reliability Standard addresses the amount of Frequency Response



## **EXHIBIT A – Criteria for Approval of Reliability Standards**

needed in each Interconnection that is required to obtain an adequate level of reliability. It then goes on to address the process to determine an appropriate Frequency Bias Setting for each Balancing Authority within those Interconnections, balancing the desire to have sustained response to frequency events and the desire to avoid excess regulation due to small frequency changes.

**6. Proposed Reliability Standards cannot be “lowest common denominator,” *i.e.*, cannot reflect a compromise that does not adequately protect Bulk-Power System reliability. Proposed Reliability Standards can consider costs to implement for smaller entities, but not at consequences of less than excellence in operating system reliability.**

The proposed Reliability Standard does not reflect a “lowest common denominator” approach. To the contrary, the proposed standard represents a significant improvement over the previous version as described herein.

**7. Proposed Reliability Standards must be designed to apply throughout North America to the maximum extent achievable with a single Reliability Standard while not favoring one geographic area or regional model. It should take into account regional variations in the organization and corporate structures of transmission owners and operators, variations in generation fuel type and ownership patterns, and regional variations in market design if these affect the proposed Reliability Standard.**

The proposed Reliability Standard applies throughout North America and does not favor one geographic area or regional model. The proposed Reliability Standard clearly addresses differences across the Interconnections by setting an Interconnection Frequency Response Obligation for each based on the size of the Interconnection as well as the resources located within that Interconnection. Since the corporate structure of the Balancing Authorities does not cause the reliability needs to change, the proposed Reliability Standard does not differentiate between the regional market designs found in an Interconnection. It simply and clearly states the performance required from each Balancing Authority within an Interconnection and allows each

## **EXHIBIT A – Criteria for Approval of Reliability Standards**

applicable entity the flexibility to address their needs as appropriate. This model provides a performance requirement without mandating how each individual entity must comply.

### **8. Proposed Reliability Standards should cause no undue negative effect on competition or restriction of the grid beyond any restriction necessary for reliability.**

The proposed Reliability Standard does not restrict the available transmission capability or limit use of the bulk-power system in a preferential manner.

### **9. The implementation time for the proposed Reliability Standard is reasonable.**

The proposed effective dates for the standard are just and reasonable and appropriately balance the urgency in the need to implement the standards against the reasonableness of the time allowed for those who must comply to develop necessary procedures, software, facilities, staffing or other relevant capability.

This will allow applicable entities adequate time to ensure compliance with the requirements. The proposed effective dates are explained in the proposed Implementation Plan, attached as **Exhibit E**.

### **10. The Reliability Standard was developed in an open and fair manner and in accordance with the Reliability Standard development process.**

The proposed Reliability Standard was developed in accordance with NERC's ANSI-accredited processes for developing and approving Reliability Standards. **Exhibit K** includes a summary of the Reliability Standard development proceedings, and details the processes followed to develop the standard.

These processes included, among other things, multiple comment periods, pre-ballot review periods, and balloting periods. Additionally, all meetings of the drafting team were properly noticed and open to the public. The initial and recirculation ballots both achieved a quorum and exceeded the required ballot pool approval levels.

### **11. NERC must explain any balancing of vital public interests in the development of**

## **EXHIBIT A – Criteria for Approval of Reliability Standards**

### **proposed Reliability Standards.**

NERC has identified no competing public interests regarding the request for approval of this proposed Reliability Standard. No comments were received that indicated the proposed standard conflicts with other vital public interests.

### **12. Proposed Reliability Standards must consider any other appropriate factors.**

No other negative factors relevant to whether the proposed Reliability Standard is just and reasonable were identified.

## EXHIBIT G - Status of Recommendations of the Frequency Response Initiative Report

The following is a list of recommendations presented in the Frequency Response Initiative Report and an explanation of the current status of those recommendations.

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**Recommendation 1:** NERC should embark immediately on the development of a NERC Frequency Response Resource Guideline to define the performance characteristics expected of those resources for supporting reliability.

- As a result of this recommendation, NERC is in the process of developing a Frequency Response Resource Guideline. NERC is assembling a group of subject matter experts in Frequency Response by conventional generating resources, as well as experts in the field of other Frequency-responsive resources to prepare the guidelines. Additionally, a third chapter on cohesive strategies for Balancing Authorities to obtain and provide primary Frequency Response is being added to the guideline.

**Recommendation 2:** Instead of using a fixed margin, the calculation of the Interconnection Frequency Response Obligations (“IFRO”) should use statistical analysis to determine the necessary margin.

- The standard drafting team adopted this method of statistical analysis in proposed Reliability Standard BAL-003-1.

**Recommendation 3:** The starting frequency for the calculation of IFROs should be the frequency 5% of the lower tail of samples from the statistical analysis, representing a 95% confidence that frequencies will be at or above that value at the start of any frequency event, as shown in table A.

Table A: Interconnection Frequency Variation Analysis (Hz)				
Value	Eastern	Western	ERCOT	Québec
Starting Frequency ( $F_{\text{start}}$ )	59.974	59.976	59.963	59.972

- The standard drafting team adopted this method of starting frequency analysis in proposed Reliability Standard BAL-003-1.

**Recommendation 4:** The recommended UFLS first-step limitations for IFRO calculations are listed in table B.

**EXHIBIT G - Status of Recommendations of the Frequency Response Initiative Report**

<b>Table B: Low-frequency Limits (Hz)</b>	
<b>Interconnection</b>	<b>Highest UFLS Trip Frequency</b>
Eastern	59.5 <sup>3</sup>
Western	59.5
ERCOT	59.3
Québec	58.5

[FN3. The highest UFLS setpoint in the Eastern Interconnection is 59.7 Hz in FRCC, based on internal stability concerns. The FRCC concluded that the IFRO starting frequency of the prevalent 59.5 Hz for the Eastern Interconnection is acceptable in that it imposes no greater risk of UFLS operation in FRCC for an external resource loss event than for an internal FRCC event.]

- The standard drafting team adopted these UFLS first-step limitations in Table B in proposed Reliability Standard BAL-003-1.

**Recommendation 5:** The allowable frequency deviation (starting frequency minus the highest UFLS step) should be reduced to account for differences between the 1-second and sub-second data for Point C (frequency nadir) by a statistically determined adjustment as listed in table C. Sub-second measurements will more accurately detect Point C.

<b>Table C: Analysis of 1-Second and Sub-Second Data for Point C (<math>CC_{ADJ}</math>)</b>				
<b>Interconnection</b>	<b>Number of Samples</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b><math>CC_{ADJ}</math> (95% Quantile)</b>
Eastern	30	0.0006	0.0038	0.0068
Western	17	0.0012	0.0019	0.0044
ERCOT	58	0.0021	0.0061	0.0121
Québec	0	N/A	N/A	N/A

- The standard drafting team adopted this method of analysis and adjusting allowable frequency deviation in proposed Reliability Standard BAL-003-1.

**Recommendation 6:** The allowable change in frequency from the IFRO Starting Frequency should be adjusted by a statistically determined value to account for the differences between the Value B and the Point C for historical frequency events as listed in table D.

**EXHIBIT G - Status of Recommendations of the Frequency Response Initiative Report**

<b>Table D: Analysis of B Value and Point C (CB<sub>R</sub>)</b>				
<b>Interconnection</b>	<b>Number of Samples</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>CB<sub>R</sub> (95% Quantile)</b>
Eastern	41	0.964	0.0149	1.0 (0.989) <sup>4</sup>
Western	30	1.570	0.0326	1.625
ERCOT	88	1.322	0.0333	1.377
Québec <sup>5</sup>	N/A	1		1.550

[FN4. CBR value limited to 1.0 because values lower than that indicate the Value B is lower than Point C and does not need to be adjusted. The calculated value is 0.989.

FN5. Based on Québec UFLS design between their 58.5 Hz UFLS with 300 millisecond operating time (responsive to Point C) and 59.0 Hz UFLS step with a 20-second delay (responsive to Value B or beyond) with a 0.05 Hz confidence interval. See the Adjustment for Differences between Value B and Point C section of this report for further details.]

- The standard drafting team adopted this method of analysis and adjusting IFRO starting frequency in proposed Reliability Standard BAL-003-1.

**Recommendation 7:** An adjustment should be made to the maximum allowable delta frequency to compensate for the predominant withdrawal of primary frequency response exhibited in an interconnection until such withdrawal is no longer exhibited in that interconnection.

- The standard drafting team adopted this method of analysis and adjusting the maximum allowable delta frequency in proposed Reliability Standard BAL-003-1.

**Recommendation 8:** The determination of the maximum delta frequencies should be calculated in accordance with the methods embodied in Table E – Determination of Maximum Delta Frequencies.

## EXHIBIT G - Status of Recommendations of the Frequency Response Initiative Report

Table E: Determination of Maximum Delta Frequencies					
	Eastern	Western	ERCOT	Québec	Units
Starting Frequency	59.974	59.976	59.963	59.972	Hz
Minimum Frequency Limit	59.500	59.500	59.300	58.500	Hz
Base Delta Frequency	0.474	0.476	0.663	1.472	Hz
$CC_{ADJ}^6$	0.007	0.004	0.012	N/A	Hz
Delta Frequency ( $DF_{CC}$ )	0.467	0.472	0.651	1.472	Hz
$CB_R^7$	1.000 <sup>8</sup>	1.625	1.377	1.550 <sup>9</sup>	Hz
Delta Frequency ( $DF_{CBR}$ ) <sup>10</sup>	0.467	0.291	0.473	0.949	Hz
$BC'_{ADJ}^{11}$	.018	N/A	N/A	N/A	Hz
Max. Delta Frequency	0.449	0.291	0.473	0.949	Hz

[FN6. Adjustment for the differences between 1-second and sub-second Point C observations for frequency events.

FN7. Adjustment for the differences between Point C and Value B.

FN8. CBR value for the Eastern Interconnection limited to 1.0 because values lower than that indicate the Value B is lower than Point C and does not need to be adjusted. The calculated value is 0.989.

FN9. Based on Québec UFLS design between their 58.5 Hz UFLS with 300 ms operating time (responsive to Point C) and 59.0 Hz UFLS step with a 20-second delay (responsive to Value B or beyond).

FN10. DFCC/CBR

FN11 Adjustment for the event nadir being below the Value B (Eastern Interconnection only) due to primary frequency response withdrawal.]

- The standard drafting team adopted the recommended method of determining Maximum Delta Frequencies (embodied in Table E) in proposed Reliability Standard BAL-003-1.



## EXHIBIT G - Status of Recommendations of the Frequency Response Initiative Report

**Recommendation 9:** The Interconnection Frequency Response Obligations should be calculated as shown in Table F: Recommended IFROs.

Table F: Recommended IFROs					
	Eastern	Western	ERCOT	Québec	Units
Starting Frequency	59.974	59.976	59.963	59.972	Hz
Max. Delta Frequency	0.449	0.291	0.473	0.949	Hz
Resource Contingency Protection Criteria	4,500	2,740	2,750	1,700	MW
Credit for LR	–	300	1,400	–	MW
IFRO <sup>12</sup>	-1,002	-840	-286	-179	MW/0.1Hz
Absolute Value of IFRO	1,002	840	286	179	MW/0.1Hz
% of Current Interconnection Performance <sup>13</sup>	40.6%	71.2%	48.7%	23.9%	
% of Interconnection Load <sup>14</sup>	0.17%	0.56%	0.45%	0.50%	

$$[FN12. \text{ IFRO} = \frac{\text{CBR} \times \text{Resource Contingency Protection Criteria}}{10 \times (\text{Starting Frequency} - \text{Minimum Frequency Limit} - \text{CC}_{AD})}$$

FN13. Current Interconnection Frequency Response Performance: EI = -2,467 MW / 0.1Hz, WI = -1,179 MW / 0.1Hz, TI = -586 MW / 0.1Hz, and QI = -750 MW/0.1 Hz.]

- The standard drafting team adopted the recommended method of calculating Maximum Interconnection Frequency Response Obligations (shown in Table F) in proposed Reliability Standard BAL-003-1.

**Recommendation 10:** NERC and the Western Interconnection should analyze the FRO allocation implications of the Pacific Northwest RAS generation tripping of 3,200 MW.

- NERC staff has begun discussions and work with the WECC Performance Subcommittee to analyze the implications of the Pacific Northwest RAS generation tripping. The maximum value of the RAS action has since been determined to be 2,850 MW, only slightly above the value for loss of two Palo Verde units recommended in the FRI report. Verification and adjustments for load tripping credit is being pursued and this analysis should be completed in the 3<sup>rd</sup> quarter of 2013.

**Recommendation 11:** Trends in frequency response sustainability should be measured and tracked by observing frequency between T+45 seconds and T+180 seconds. A pair of indices for



## **EXHIBIT G - Status of Recommendations of the Frequency Response Initiative Report**

gauging sustainability should be calculated comparing that value to both the Point C and Value B.

- NERC staff has begun calculating and tracking frequency response sustainability for the frequency events starting in 2013, and will be performing retroactive calculations of the recommended indices for frequency events analyzed for 2011 and 2012.

**Recommendation 12:** Frequency response performance by Balancing Authorities should not be judged for compliance on a per-event basis.

- The standard drafting team agreed with this recommendation and did not adopt a per-event compliance measure in proposed Reliability Standard BAL-003-1. As set forth in the *Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard*, NERC will identify 20 to 35 frequency excursion events in each interconnection for calculating the Frequency Bias Setting and the Frequency Response Measure. The evaluation period for performing the annual Frequency Bias Setting and the Frequency Response Measure calculation is December 1 of the prior year through November 30 of the current year.

**Recommendation 13:** Linear regression is the method that should be used for calculating Balancing Authority Frequency Response Measure (FRM) for compliance with Standard BAL-003-1 – Frequency Response.

- The standard drafting team did not adopt a linear regression method for calculating the Balancing Authority Frequency Response Measure for compliance with BAL-003-1 – Frequency Response. However, the standard drafting team did agree that linear regression should be re-evaluated for use in the standard once more experience is gained with data collected.
- NERC and the Frequency Working Group will include an update of the linear regression analysis from the FRI report during the annual review process noted under Recommendation 14.

**Recommendation 14:** NERC and the Frequency Working Group should annually review the process for detection of frequency events and the method for calculating the A and B Values and Point C. The associated interconnection frequency event database, methods for calculating interconnection metrics on risks to reliability, the associated probabilities, and the calculation of the IFROs using updated data should also undergo review in an effort to improve the process. Throughout this process, NERC should strive to improve the quality and consistency of the data measurements.

- NERC and the Frequency Working Group have set forth a process for identification of candidate frequency events, and an annual review of the calculations. NERC staff will

## **EXHIBIT G - Status of Recommendations of the Frequency Response Initiative Report**

work with the Frequency Working Group throughout the year to continuously refine and improve the review process.

**Recommendation 15:** NERC should address improving the level of understanding of the role of turbine governors through seminars and webinars, with educational materials available to the Generator Owners and Generator Operators on an ongoing basis.

- NERC is planning to prepare training materials to share with the Generation Owner and Balancing Authority communities. Annual training sessions for Balancing Authority reporting and the Frequency Response resource guidelines are planned.

**Recommendation 16:** When the Eastern Interconnection Reliability Assessment Group Multiregional Modeling Working Group (ERAG MMWG) completes its review of turbine governor modeling, a new light-load case should be developed, and the resource loss criterion for the Eastern Interconnection's IFRO should be re-simulated.

- ERAG MMWG has agreed to prepare an updated "generic governor" 2013 summer light load case (from the 2012 case series) for evaluating Eastern Interconnection IFROs by August 1, 2013. That case will use generic governor models to mimic the frequency response performance characteristics determined in the "Analysis of Eastern Interconnection Frequency Response" report published in March 2012. ERAG Management Committee is targeting completion of the governor review and case creation by August 1, 2014.

**Recommendation 17:** Eastern Interconnection inter-area oscillatory behavior should be further investigated by NERC, including the testing of large resource loss analysis for IFRO validation.

- Work on such analysis is being proposed to the NERC Planning Committee, System Analysis and Modeling Working Subcommittee.

## **EXHIBIT K – Summary of the Reliability Standard Development Proceeding**

### **SUMMARY OF THE RELIABILITY STANDARD DEVELOPMENT PROCEEDING**

#### **A. Overview of the Standard Drafting Team**

The Frequency Response Standard Drafting Team is comprised of some of the foremost experts in the field. The team is chaired by David Lemmons, Senior Manager, Market Operations at Xcel Energy, and vice-chairman, Dr. Terry Bilke, Consulting Advisor in Compliance Services at the Midwest Independent System Operator, Inc. Drafting Team members include Howard Illian of Energy Mark, Inc., who has published a variety of papers on the subject of Frequency Response, including a 2010 report that was funded by the FERC, Office of Electric Reliability,<sup>29</sup> Sydney Niemeyer, a Control System Specialist at NRG Texas, LP, Michael Potishnak, a principal engineer at ISO New England, Inc., and Carlos Martinez, who has also published several papers on the subject of Frequency Response, including a 2010 report that was funded by the FERC, Office of Electric Reliability that reviewed the frequency performance of the Eastern, Western and ERCOT interconnections.<sup>30</sup>

Don Badley has been a member of the Northwest Power Pool (“NWPP”) Staff since 1975. Don manages the NWPP Operating Committee. He is currently Chairman of the NERC Resources Subcommittee, a member of Western Electricity Coordinating Council’s (WECC) Performance Work Group and has chaired numerous NERC and WECC groups. In the past Mr. Badley has served as Chairman of the North American Power Systems Interconnection Committee’s Performance Subcommittee, a member of the WECC Technical Operations

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<sup>29</sup> See e.g., Illian, H. (2010), *Frequency Control Performance Measurement and Requirements*, LBNL-2145E, Ernest Orlando Lawrence Berkeley National Laboratory; available at: <http://www.ferc.gov/eventcalendar/Files/20110120114346-Frequency-Control-Performance-Measurement-and-Requirements.pdf>; Eto, J. H., Undrill, J., Mackin, P., Daschmans, R., Williams, B., Illian, H., et al. (2010). *Use of Frequency Response Metrics to Assess the Planning and Operating Requirements for Reliable Integration of Variable Renewable Generation*. LBNL-4142E. Ernest Orlando Lawrence Berkeley National Laboratory; available at: <http://www.ferc.gov/industries/electric/indus-act/reliability/frequencyresponsemetrics-report.pdf>.

<sup>30</sup> Martinez, C., Xue, S., Martinez, M (2010), *Review of the Recent Frequency Performance of the Eastern, Western and ERCOT Interconnections*, LBNL-4144E; available at: <http://www.ferc.gov/industries/electric/indus-act/reliability/interconnectionfrequencyperformance.pdf>.

## **EXHIBIT K – Summary of the Reliability Standard Development Proceeding**

Subcommittee, and a member of the WECC Control Work Group. Mr. Badley is a member of the IEEE Power Engineering Society and has co-authored three IEEE papers on system control.

Mr. Clyde Loutan is presently a Senior Advisor at the California Independent System Operator Corporation (“ISO”) focusing on power system operation performance, and was the lead investigator for the ISO’s renewable resource integration studies published in 2007 and 2010. Mr. Loutan was also the principal investigator for the ISO’s Frequency Response Study<sup>31</sup> done by General Electric International, Inc. and the ISO to investigate the ISO’s frequency response due to large loss-of-generation under conditions with high levels of wind and solar generation published in 2011. He co-authored an IEEE technical paper on “Frequency Response of California and WECC under High Wind and Solar Conditions,” which was presented at the 2012 IEEE Power & Energy Society General Meeting on July 24 in San Diego California. Mr. Loutan previously worked at the Pacific Gas and Electric Company for 14 years in various capacities such as Real Time System Operations, Transmission Planning and High Voltage Protection. Mr. Loutan is a licensed professional engineer in the State of California. He holds B.S. and M.S. degrees in Electrical Engineering from Howard University in Washington D.C., and is a senior member of the IEEE.

Darrel Richardson, with over thirty-seven years of experience in the electric industry, is the NERC Standards Developer for the project. Robert Cummings, Director of Reliability Initiatives and System Analysis, supported the drafting team via the Frequency Response Initiative and the publication of the related report, included herein as **Exhibit F**. Mr. Cummings, an IEEE Senior Member, who joined NERC in 1996, has over thirty-six years of extensive experience in the industry in system planning, operations engineering, and wide area planning.

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<sup>31</sup> <http://www.caiso.com/Documents/Report-FrequencyResponseStudy.pdf>

## **EXHIBIT K – Summary of the Reliability Standard Development Proceeding**

### **B. Standard Authorization Request Development**

The Standard Authorization Request (“SAR”) for BAL-003-1 was submitted on April 7, 2004 as a request for a new Frequency Response Standard. The initial draft of the SAR was posted from January 17, 2005 to February 17, 2005 for a 30-day public comment period. A white paper prepared by the Frequency Task Force of the NERC Resources Subcommittee was posted with the first draft of the SAR. Based on industry comments, the drafting team revised the SAR and posted a second draft for comment from April 4, 2006 to May 3, 2006. Following further modifications, a third draft of the SAR was posted from February 8, 2007 to March 9, 2007. In these successive drafts, the standard drafting team further defined the scope of the standard, identified applicability, and came to a consensus on the need to specify the quality and quantity of frequency response. A fourth and final draft of the SAR was posted on June 30, 2007 and the drafting team was formed on July 30, 2007.

### **C. The First Posting – Informal Comment Period**

The first draft of BAL-003-1 was posted for a 30-day comment period from February 4, 2011 to March 7, 2011. Several documents were posted for guidance with the first draft, including Attachment A to the standard, a supplemental SAR identifying the modifications to BAL-003-0 that were originally part of Project 2007-18 – Reliability-based Control, a Frequency Response Survey Form that was used for data collection, and a document containing the outline of a proposed field test to be used in creating the standard. There were 36 sets of comments on the first draft, with comments from more than 139 different people from approximately 86 companies representing all 10 of the industry segments. In response to comments, the standard drafting team made several changes to the draft standard including:

## **EXHIBIT K – Summary of the Reliability Standard Development Proceeding**

- Removed the Single Event Frequency Response Data (SEFRD) definition and modified several others;
- Modified Attachment A, and created Attachment B – Process for Adjusting Bias Floor Setting;
- Modified FRS Form 1 to correct errors, allow for adjustments and provide clarity; and
- Added VRFs and VSLs.

### **D. The Second Posting – Formal Comment Period, Initial Ballot and Non-Binding Poll**

The second draft of the standard was posted for a formal 45-day comment period from October 25, 2011 to December 9, 2011, with an initial ballot held from November 30, 2011 to December 9, 2011. The initial ballot achieved a 93.92% quorum, and an approval of 30.82%. The standard drafting team received 43 sets of comments from 133 different people from approximately 86 different companies representing all 10 industry segments. Several changes were made to the draft of the BAL-003-1 standard including:

- Modified the definitions for Frequency Response Measure (FRM) and Frequency Bias Setting;
- Removed the references to Reserve Sharing Groups (RSGs) and replaced them with a new definition Frequency Response Sharing Group (FRSG) and defined FRSG;
- Modified Requirement R2 to provide clarity and incorporate Requirement R5;
- Created a new Requirement R3 for entities using variable Frequency Bias
- Removed the requirement for operating in Tie Line Bias mode as duplicative of other requirements in other standards;
- Modified Attachment A to provide additional clarity;
- Re-wrote the Background Document to incorporate additional language for justification of requirements and provide additional clarity;
- Created a procedure document for the ERO support of the standard; and
- Adopted the Frequency Response Initiative Report methodology for calculating the Interconnection Frequency Response Obligation (IFRO)

### **E. Frequency Response Technical Conferences**

In order to obtain industry input of the development of the Frequency Response standard, NERC held technical conferences in Arlington, Virginia on May 22, 2012, and in Denver,

## **EXHIBIT K – Summary of the Reliability Standard Development Proceeding**

Colorado on May 24, 2012. The conferences focused on discussing which Functional Entities should be responsible for Frequency Response and how Frequency Response should be measured. NERC solicited comments on the standard, the development process, and the topics discussed at the technical conference and gave a deadline of June 15, 2012 for comment submission.

### **F. Third Posting - Formal Comment Period, Successive Ballot, and Non-Binding Poll**

The third draft of the standard was posted with the implementation plan, mapping document, Attachment A to the standard, FRS Forms 1 and 2, a procedure document for ERO support of the standard, and a background document on the development, testing and implementation of the BAL-003-1 standard. The 30-day comment period ran from October 5, 2012 to November 6, 2012, and included a successive ballot and non-binding poll from October 26, 2012 to November 6, 2012. The successive ballot for the draft of BAL-003-1 received a quorum of 82.04% and a 76.08% approval. The non-binding poll received a quorum of 76.28% and a 76.30% approval. The standard drafting team received 50 sets of comments from 144 individuals from 100 different companies representing eight of the ten industry segments. As a result of the industry comments, the standard drafting team made changes to the standard including:

- Made language and grammatical corrections in the proposed standard;
- Clarified the description of the calculation for the Interconnection Frequency Response Obligation (“IFRO”) in Attachment A to the standard; and
- Modified Attachment A and the Procedure for consistency on the use of the term “resource contingency criteria.”

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### **G. Fourth Posting – Recirculation Ballot**

The fourth draft of the BAL-003-1 standard was posted for a recirculation ballot from December 12, 2012 to December 21, 2012. The recirculation ballot achieved a quorum of 86.19% and an approval of 76.53%.

### **H. Board of Trustees Approval of BAL-003-1**

The final proposed BAL-003-1 standard was presented to the NERC Board of Trustees on February 7, 2013. NERC staff provided a summary of the proposed standard, as well as a summary of minority issues and associated drafting team responses. The NERC Board of Trustees approved the standard, and NERC staff recommended that it be filed with applicable governmental authorities.



**EXHIBITS B, C, D, E, F, H, I, J, and L**

(Available on the NERC Website at  
[http://www.nerc.com/fileUploads/File/Filings/Attachments\\_BAL-003-1\\_Filing](http://www.nerc.com/fileUploads/File/Filings/Attachments_BAL-003-1_Filing))