



NERC proposes to hold two technical conferences in order to educate the industry regarding Frequency Response.<sup>3</sup> The first conference will be held on or about May 22, 2012 on the East Coast and the second on or about May 24, 2012 toward the West Coast, in order to maximize possible attendance. A draft technical conference agenda is included herein for informational purposes as **Attachment A**.

Following the technical conferences, NERC will provide for a 30-day comment period to allow comments on the revised draft standard. NERC proposes to file a revised timeline for completing the revisions to BAL-003 with the Commission no later than 21 days following the end of the comment period (*i.e.*, no later than 51 days after the second technical conference). This period of time will allow NERC and the Standard Drafting Team appointed to develop the proposed modifications to BAL-003 to comply with the Commission's directives (the "NERC Frequency Response Standard Drafting Team" or "Standard Drafting Team") to complete necessary research, gain support for the current draft of the standard and will allow for input from both the industry and the Commission. Following the technical conferences in May, NERC proposes to make informational filings with the Commission on a quarterly basis to keep the Commission informed of its continual progress with respect to Frequency Response and the revision of BAL-003.

Included herein (at Section II) for reference purposes, is background information with respect to some of the issues involved with Frequency Response and Frequency Bias. These are highly technical issues comprised of several components, beginning with the initial response of generators and loads to a frequency excursion, and have required numerous studies and analyses to understand the myriad issues involved.

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<sup>3</sup> See *infra* at Section IV.

## I. BACKGROUND

As the Commission-certified Electric Reliability Organization (“ERO”), NERC is vested with the primary responsibility for developing reliability standards and modifications to existing standards, subject to the review and approval of the Commission.<sup>4</sup> Section 215(d)(2) of the Federal Power Act (“FPA”) requires the Commission, when considering whether to approve a proposed standard or modification, to “give due weight to the technical expertise” of NERC. If the Commission disapproves of a proposed standard in whole or in part, Section 215(d)(4) provides that the Commission must remand the standard to NERC for further consideration; the Commission cannot unilaterally modify NERC’s proposed standards.<sup>5</sup>

### A. Commission Directives on Frequency Response

In Order No. 693, issued on March 16, 2007, the Commission 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 balancing authority with methods of obtaining and measuring that the frequency response is achieved.

On March 18, 2010, the Commission issued an Order Setting Deadline for Compliance<sup>6</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

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<sup>4</sup> See 16 U.S.C. §§ 824o(a)(2), (d)(1)-(2); *North American Electric Reliability Corp.*, 116 FERC ¶ 61,062 (2006), *order on reh’g & compliance*, 117 FERC ¶ 61,126 (2006).

<sup>5</sup> See 16 U.S.C. § 824o(d)(2), (4).

<sup>6</sup> *Mandatory Reliability Standards for the Bulk Power System*, Order Setting Deadline for Compliance, 130 FERC ¶ 61,218 (2010)(“March 18 Order”).

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>7</sup>

On May 13, 2010, FERC issued an Order Granting Rehearing for Further Consideration and Scheduling Technical Conference (“Order Granting Rehearing”).<sup>8</sup> Specifically, the 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 Order Granting Rehearing, the Commission 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 Order, the Commission deferred the six-month compliance deadline included in the March 18 Order.<sup>9</sup>

On October 14, 2010, as directed in the Order Granting Rehearing, NERC filed Comments Following the September 23 Frequency Response Technical Conference.<sup>10</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

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<sup>7</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>8</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>9</sup> *Id.* at P 2.

<sup>10</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).

project by May 2012. However, NERC has continuously stated 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>11</sup> On December 16, 2010, the Commission accepted NERC's anticipated May 2012 target date.<sup>12</sup>

## **II. FREQUENCY RESPONSE AND FREQUENCY BIAS**

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. Frequency Response is the traditional metric used by the industry to describe how an interconnection has performed in stabilizing frequency after the loss of generation or loss of load. Power system operators manage or control frequency primarily through adjustments to the output 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.

Primary frequency control involves the autonomous, automatic, and rapid action of a generator 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

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<sup>11</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>12</sup> *Mandatory Reliability Standards for the Bulk-Power System*, 133 FERC ¶ 61,212 (2010).

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) 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.<sup>13</sup> The 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 Automatic Generating Control (“AGC”) to prevent AGC from withdrawal of generator primary control action following a disturbance as long as the frequency is off nominally. 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.

Following the sudden loss of generation in an interconnection, the point at which frequency decline stops is called the “frequency nadir.”<sup>14</sup> *See* Point C below. The point at which frequency is stabilized is called the “Settling Frequency” or “Settled Frequency Response.” *See* Value B below. Until recently, power system technologies such as System Control and Data Acquisition (“SCADA”) could not accurately measure the frequency nadir which occurs within the initial seconds following the sudden loss of generation because the scan rates of the

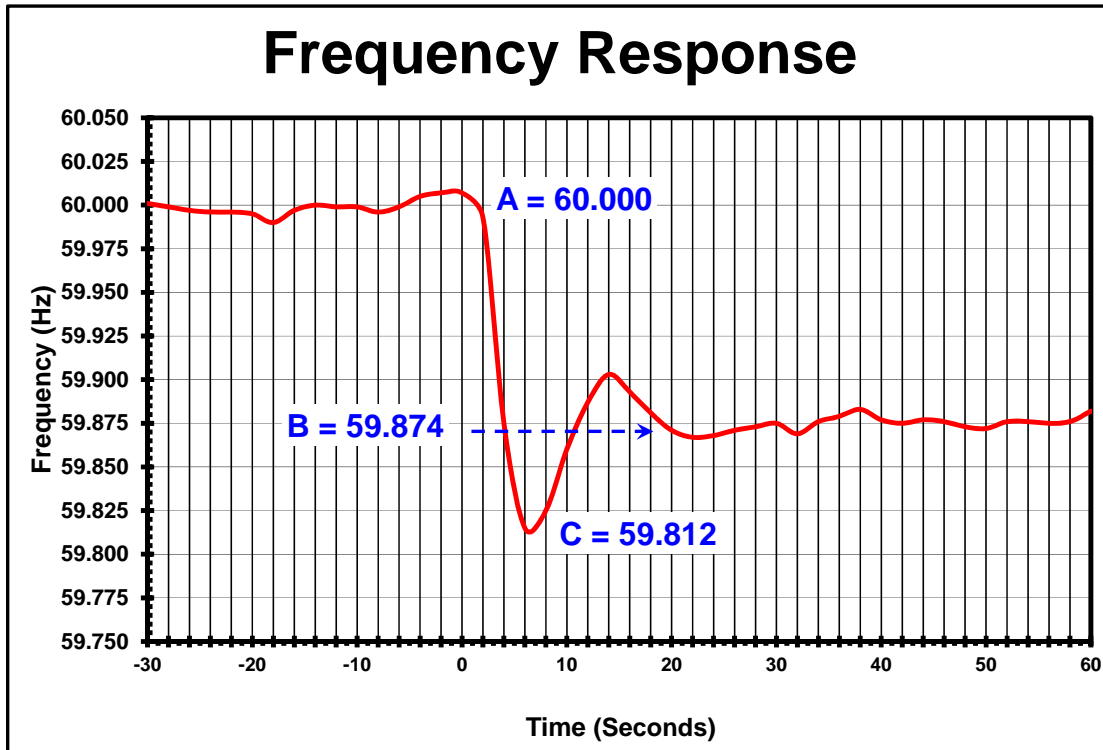
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<sup>13</sup> See Attachment B, Frequency Response Standard Background Document.

<sup>14</sup> See 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.

measurements is too slow (once every 2 to 6 seconds). In addition, the probability of scanning and recording frequency at precisely the instant that the frequency reaches the frequency nadir is extremely low. The advent of high-speed measurement capabilities such as synchrophasors (known as “phasor measurement units” or “PMUs”) now allow more accurate measurement of the nadir; however, there are currently only a few hundred of those devices in service in North America.

In the following figure, the effect of a Frequency Response event is illustrated.



**FIGURE 1: Frequency Response Event**

**Value A: Pre-disturbance Frequency**

**Value B: Settling Frequency**

**Point C: Frequency Nadir**

Another measure of interest when developing a Frequency Response estimate is known as “Arrested Frequency Response.” Arrested Frequency Response is based upon the change in

frequency between the initial frequency, Value A, and the frequency nadir, Point C, during a frequency event, while Settled Frequency Response is based upon the change in frequency between Value A and Value B. The Standard Drafting Team believes that Arrested Frequency Response is a more accurate method for determining the minimum Frequency Response related to under-frequency relay operation and the support of interconnection reliability because it can be used to provide a direct estimate of the maximum frequency deviation an interconnection will experience for an initial frequency and a given size event in megawatts (“MW”).<sup>15</sup> However, Arrested Frequency Response cannot currently be measured using the existing measurement infrastructure. As illustrated above, Frequency Response events occur in *seconds*. The scan rates currently used in industry Energy Management Systems (“EMSs”) are incapable of measuring the Net Actual Interchange<sup>16</sup> for a Balancing Area at the same instant that the maximum frequency deviation is reached during a frequency event. However, the ratio of Arrested Frequency Response and Settled Frequency Response tends to be stable on an interconnection-wide basis. This allows the Settled Frequency Response value to be used as a surrogate for the Arrested Frequency Response and is a reasonable measure on which to base a Reliability Standard.

As the PMU infrastructure is expanded in North America and more accurate measurements of frequency nadir simultaneous with the Net Actual Interchange for a Balancing Authority become available, the Frequency Response Obligation may transition to a measurement based on the Arrested Frequency Response, while the Frequency Bias Setting will continue to be based on the Settled Frequency Response. However, at this time, the measurement devices and methods in use on the bulk power system do not support the necessary

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<sup>15</sup> See Attachment B, Frequency Response Standard Background Document at pp. 7-8.

<sup>16</sup> The term “Net Actual Interchange” is defined in the NERC Glossary as “The algebraic sum of all metered interchange over all interconnections between two physically Adjacent Balancing Authority Areas.”



level of accuracy to estimate Arrested Frequency Response contribution for an individual Balancing Authority in most of the interconnections. The inability to accurately measure the Arresting Frequency Response has been a significant barrier to the development of a Reliability Standard that assumes sufficient reliability performance can be measured through capturing the Arresting Frequency Response.

Frequency Response is a fundamental component to the reliable operation of the bulk power system, particularly during disturbances and restoration. It must be evaluated on an interconnection-wide basis in order to then establish the Frequency Response responsibilities for an individual Balancing Authority. The amount of Frequency Response required on an interconnection-wide basis is known as the Interconnection Frequency Response Obligation (“IFRO”).

#### **A. History of Frequency Response and its Decline**

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 (now the Resources Subcommittee of the Operating Committee), charged with monitoring the control performance of the interconnections, observed that generator’s governor responses to frequency deviations had been decreasing especially in the Eastern Interconnection. The result was quite noticeable during large generation losses where the frequency deviation was

not arrested as quickly as it once was. The industry did not initially recognize that power systems operations could significantly influence primary Frequency Response.<sup>17</sup>

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*.<sup>18</sup> These studies indicated that the Frequency Response of the interconnections was declining at rates greater than would be expected with the growth of demand and generating capacity.<sup>19</sup> Although Frequency Response was declining, the opinion of experts at the time was that the decline had not reached a point where reliability was being compromised.

The NERC Resources Subcommittee proposed a Frequency Response Standard for comment in 2001. In response to these comments, the Frequency Task Force of the NERC Resources Subcommittee published a *Frequency Response Standard Whitepaper*<sup>20</sup> 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 observed in Frequency Response in the Eastern and Western Interconnections.

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<sup>17</sup> See Illian, H.F. *Frequency Control Performance Measurement and Requirements*, LBNL-4145E (December 2010).

<sup>18</sup> EPRI Report TR-101080, *Impacts of Governor Response Changes on the Security of North American Interconnections*, October 1992.

<sup>19</sup> See EPRI Report TR-101080, *Impacts of Governor Response Changes on the Security of North American Interconnections*, October 1992 ("An analysis of the 14 Frequency Response Characteristics Surveys conducted by NERC over the 1971 to 1993 period showed that the Frequency Response in percent MW/O. 1Hz has deteriorated. This value in 1971 was between 2.25 to 3.25% (depending on the area) and by 1993 had dropped to 0.75 and 1.25%.").

<sup>20</sup> Available here: [http://www.nerc.com/docs/oc/rs/Frequency\\_Response\\_White\\_Paper.pdf](http://www.nerc.com/docs/oc/rs/Frequency_Response_White_Paper.pdf) ("Frequency Response Standard Whitepaper").

## **B. Current Projections of Frequency Response Decline**

In August 2011, the Transmission Issues Subcommittee<sup>21</sup> of the NERC Planning Committee completed an analysis *Interconnection Criteria for Frequency Response Requirements – Determination of Interconnection Frequency Response Obligations*.<sup>22</sup> The analysis included comparisons of various Resource Contingency Protection Criteria for loss of resources, including: largest potential loss-of-resource event (N-2), the largest total generating plant with common voltage switchyard, and the largest loss of generation in the interconnection in the last 10 years. Also examined in that analysis were the various other factors that must be considered in an IFRO determination: the highest underfrequency load shedding (“UFLS”) program setpoint within each interconnection, special consideration of demand-side frequency responsive programs in ERCOT, and a reliability margin to account for the variability of frequency due to items such as time error correction, variability of load, variability of interchange, variability of frequency over the course of a normal day, and other uncertainties. The proposed margin was analyzed using a probabilistic approach based on 1-minute frequency performance data for each interconnection. The Transmission Issues Subcommittee recommended the following IFROs for the four interconnections: Eastern – -1,875 MW/0.1 Hz, Western – -637 MW/0.1 Hz, Texas – -327 MW/0.1 Hz, and Québec – -113 MW/0.1 Hz. The Transmission Issues Subcommittee IFRO report was approved by the NERC Planning Committee in September 2011 and forwarded to the Standard Drafting Team for their consideration.

A similar report had been prepared by the Resources Subcommittee of the NERC Operating Committee in January 2011, *NERC Resources Subcommittee Position Paper on*

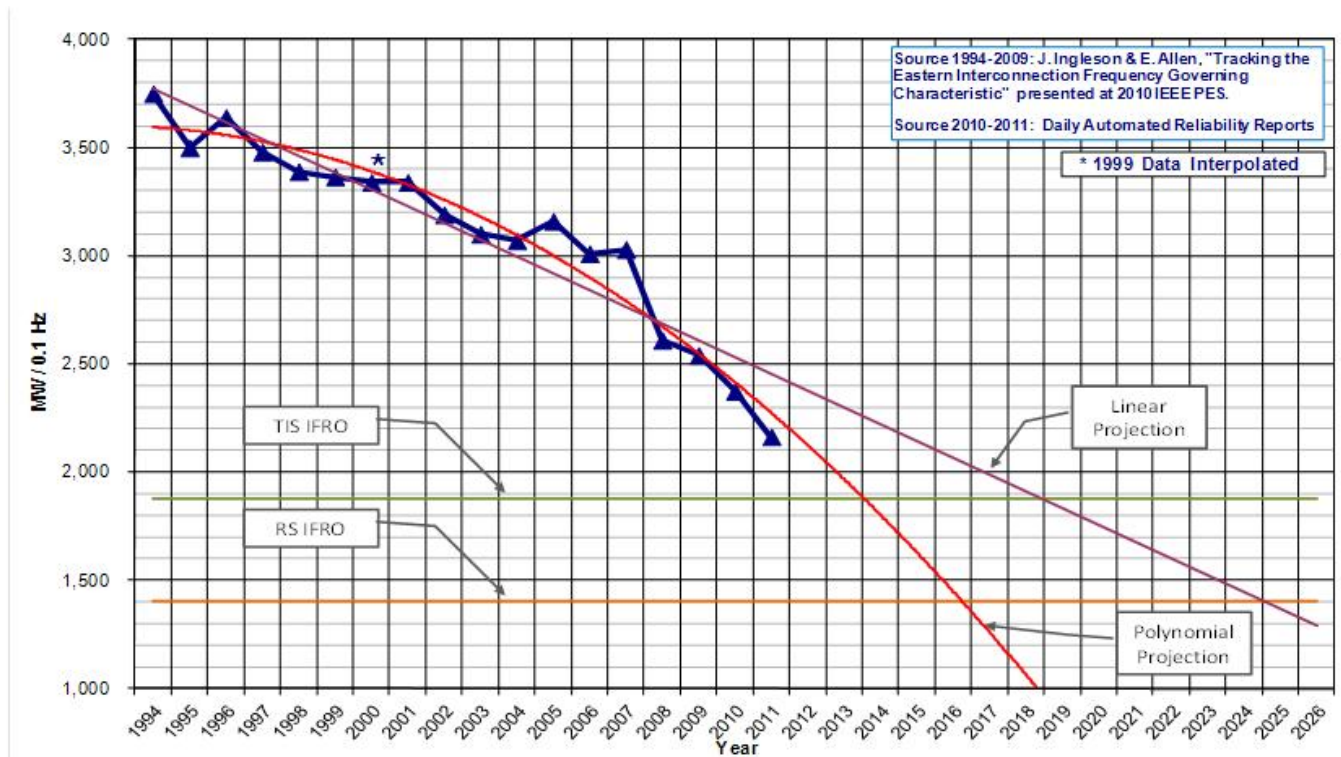
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<sup>21</sup> The Transmission Issues Subcommittee is now the System Analysis and Modeling Subcommittee (SAMS).

<sup>22</sup> Available here:

[http://www.nerc.com/docs/pc/tis/Agenda\\_Item\\_5.d\\_Draft\\_TIS\\_IFRO\\_Criteria%20Rev\\_Final.pdf](http://www.nerc.com/docs/pc/tis/Agenda_Item_5.d_Draft_TIS_IFRO_Criteria%20Rev_Final.pdf).

Frequency Response.<sup>23</sup> That report used similar Resource Contingency Protection Criteria, but used the prevalent 59.5 Hz highest UFLS setpoint for the Eastern Interconnection, and a lower 59.3 Hz UFLS setpoint for ERCOT. The Resources Subcommittee analysis also used a 25% reliability margin for all four interconnections. The Resources Subcommittee recommended the following IFROs for the four interconnections: Eastern – -1,406MW/0.1 Hz, Western – -685 MW/0.1 Hz, Texas – -286 MW/0.1 Hz, and Québec – -141 MW/0.1 Hz. The Resources Subcommittee position paper was approved by the Operating Committee in March 2011 and was considered by the Frequency Response Standard Drafting Team. NERC has been tracking the decline of Frequency Response in the Eastern Interconnection for several years. The figure below shows how Frequency Response has declined since 1994.



**FIGURE 2: Eastern Interconnection Mean Primary Frequency Response<sup>24</sup>**

<sup>23</sup> Available here: [http://www.nerc.com/docs/oc/rs/NERC%20RS%20Position%20Paper%20on%20Frequency%20Response%20Final%20\(May%2027%202011\).pdf](http://www.nerc.com/docs/oc/rs/NERC%20RS%20Position%20Paper%20on%20Frequency%20Response%20Final%20(May%2027%202011).pdf).

<sup>24</sup> The Frequency Response data from 1994 through 2009 displayed in Figure 2 is from a report by J. Ingleson & E. Allen, Tracking the Eastern Interconnection Frequency Governing Characteristic presented at the 2010 IEEE

Comparing the proposed IFROs from those two studies, the Eastern Interconnection IFROs range from about 1,400 MW/0.1 Hz to about 1,900 MW/0.1 Hz, the linear projection of the Frequency Response decline intercepts those target IFROs between 2019 and 2024. Even the more pessimistic polynomial projection of the decline intercepts the proposed IFROs between 2014 and 2016. This shows that there is still some time for revising BAL-003 and responding to the decline in Frequency Response.

As more of the industry becomes aware of the problem, the rate of decline may slow further. Most in the industry agree that there is currently adequate Frequency Response performance at this point in all of the interconnections.<sup>25</sup> Further, the initial calculations of the IFRO for the Eastern Interconnection were based on protection of a 4,500 MW loss of resources. Although that resource contingency is large, the largest sustainable resource loss for the Eastern Interconnection remained in question.

In December 2011, NERC staff and the NERC-Eastern Interconnection Reliability Assessment Group jointly developed a modified dynamics case to determine what the Frequency Response performance characteristics were for the Eastern Interconnection based on actual readings during a loss of 4,500 MW of generation event. That analysis was performed using generator governor models with tightly controlled parameters to mimic the measured response. The modified case showed that about 30% of the generation on line responded to the loss of generation, but also showed a characteristic of 20% of the generation on line withdrawing its

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Power and Energy Society meeting. Data from 2010 and 2011 is based on the daily Automated Reliability Reports (ARR) which tracks Frequency Response for the largest frequency perturbation each day.

<sup>25</sup> See e.g., NERC Resources Subcommittee Position Paper on Frequency Response, available here: [http://www.nerc.com/docs/oc/rs/NERC%20RS%20Position%20Paper%20on%20Frequency%20Response%20Final%20\(May%2027%202011\).pdf](http://www.nerc.com/docs/oc/rs/NERC%20RS%20Position%20Paper%20on%20Frequency%20Response%20Final%20(May%2027%202011).pdf).

response, leaving only 10% of the generation providing a sustained response. That characteristic response was then extrapolated using the modified dynamics case for larger generation losses. That analysis indicates that the Eastern Interconnection could withstand a loss of resources of about 8,500 MW with its current levels of Frequency Response before UFLS programs would be activated by the frequency excursion. That leaves a significant amount of margin between the 4,500 MW resource loss criteria in the Transmission Issues Subcommittee and Resource Subcommittee studies and the preliminary sustainable loss determined by the dynamics analysis. In order to support the development of the BAL-003 reliability standard, further studies in testing the locational sensitivities of a large potential generation loss are underway using the modified dynamics case. That analysis will also compare sensitivities to those generation losses over a range of UFLS setpoints from 59.5 Hz to 59.7 Hz. The results of that analysis are expected to be highlighted at the proposed technical conferences.

This analysis, coupled with the IFRO target analysis of the trend in Frequency Response decline, supports the notion that there is time to arrest the decline of Frequency Response in the Eastern Interconnection, and considerable headroom in the size of loss-of-resources that can be sustained.

### **C. Potential Causes of Frequency Response Decline**

The root cause of the decline of Frequency Response is likely multifaceted and is ultimately indeterminable. Certainly, the restructuring of the electric industry has affected the decline of Frequency Response as the number of vertically integrated utilities has greatly decreased in recent decades. This trend has separated generating owning entities from knowledge of the operational aspects of the bulk power system. Separately, there is the issue of financial congruency with the needs of the system. As market-oriented structures have expanded

in North America to include a greater proportion of the electrical energy produced, the particular market rules prevail and govern the behavior of the participating generating companies. In most instances, the energy market rules require generators to deliver according to a strict schedule and deviations are subject to penalties. Inherently, a generator providing automatic Frequency Response would need to deviate from their strict schedule and in essence be penalized. Without incentives to respond to frequency decline, generators operators could potentially disable frequency responsive governor controls or set their deadbands so wide that the units will not respond.<sup>26</sup>

Additionally, the changing composition of the generation fleet has also likely contributed to the decline. New combined-cycle plants are displacing older steam plants. These newer combined-cycle plants are often run at very sensitive operating points that optimize their fuel consumption performance and minimize emissions. The result is that their turbine controls counteract the potential for the generator to provide Frequency Response. The potential future impact of integrating substantial levels of electronically-coupled highly variable output renewable resources, which do not have primary Frequency Response, also must be evaluated.<sup>27</sup> However, if properly engineered, the programmable nature of the electronic coupling offers the potential for offering a significant new source of primary Frequency Response.

#### **D. Frequency Response Market Component**

Reliability and electric energy markets, including those for ancillary services, are fundamentally interdependent and essential for efficient and reliable delivery of electric power. The Commission has approved Regulation and Frequency Response as an ancillary service under

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<sup>26</sup> A survey by NERC in 2010 showed deadbands as high as 150 millihertz.

<sup>27</sup> See 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.

the *pro forma* Open Access Transmission Tariff, however, this was created prior to the implementation of markets for ancillary services. In some ways, Frequency Response is similar to both reactive power and installed capacity. It is a reliability-driven product and provides a benefit to the entire bulk-power system. Like reactive power and installed capacity, Frequency Response is essential to ensure the reliable operation of the North American power grid.

Currently, there are no ancillary services markets that are designed to directly compensate generators for providing Frequency Response. Without a market, there is simply no incentive for generators to supply Frequency Response and this is likely one of the contributing factors to the decline of Frequency Response described herein. A Reliability Standard could potentially have a disproportionate economic impact on those entities responsible for generation-demand-interchange balance in a Balancing Authority Area, despite the fact that the reliability benefits provided by such requirements would be realized on an interconnection-wide basis. A market mechanism is one way to potentially alleviate this possible impact and could ensure that adequate Frequency Response is maintained and that providers of such service are adequately compensated on a non-discriminatory basis. Transparent and non-discriminatory ancillary service markets for Frequency Response have the potential to promote reliability.

Both NERC and the Commission are prohibited by the savings provisions of Section 215 of the FPA from requiring the construction of additional generation or transmission capacity to enforce compliance with Reliability Standards. Section 215(i)(2) provides:

This section does not authorize the ERO or the Commission to order the construction of additional generation or transmission capacity or to set and enforce compliance with standards for adequacy or safety of electric facilities or services.



For these reasons, NERC has consistently supported simultaneous FERC, NERC, and industry efforts to solve the problem of Frequency Response using a market solution developed in parallel with the a standards development project instead of attempting to solve the issue with a Reliability Standard exclusively.<sup>28</sup>

NERC's Market Principles require NERC to not preclude or interfere with market solutions to achieving compliance with a standard and to neither mandate nor prohibit any specific market structure.<sup>29</sup> Order No. 672 also requires NERC to develop Reliability Standards that do not have an undue negative effect on competition.<sup>30</sup> Consistent with these principles, NERC has acknowledged that a Frequency Response reliability standard should not preclude market solutions and that there must be a means for sale/purchase of Frequency Response as for any other commodity.<sup>31</sup> As NERC noted in its *Frequency Response Standard Whitepaper*, “[w]ithout a measure or requirement, market forces will likely continue to drive a decline in [Frequency Response] performance.”<sup>32</sup>

Deployment of a market for Frequency Response ancillary services cannot be initiated by NERC. Defining the requirements for adequate Frequency Response is only part of the answer. Designing and implementing a mechanism to incentivize entities that participate in electric energy markets to provide the service is required. This would best be done simultaneously with the development of the requirements for Frequency Response. Without such a market, the alternative is to create standard requirements applicable to generators requiring them to provide

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<sup>28</sup> See *Request of the North American Electric Reliability Corporation for Clarification and Rehearing of the Order Setting Deadline for Compliance*, Docket No. RM06-16-010 (April 19, 2010) at p. 11.

<sup>29</sup> Available here: [http://www.nerc.com/files/Market\\_Principles.pdf](http://www.nerc.com/files/Market_Principles.pdf).

<sup>30</sup> *Rules Concerning Certification of the Electric Reliability Organization; and Procedures for the Establishment, Approval, and Enforcement of Electric Reliability Standards*, Order No. 672, FERC Stats. & Regs. ¶ 31,204 at P 332, *order on reh'g*, Order No. 672-A, FERC Stats. & Regs. ¶ 31,212 (2006).

<sup>31</sup> *Frequency Response Standard Whitepaper* at 17.

<sup>32</sup> *Id.* at 14.

Frequency Response. In areas that have an established electric energy market, this may place an undue economic burden on generators in the market.

Fundamentally, a market solution is required in order for the Balancing Authorities that operate in the footprint of an electric energy market to incentivize generators to provide Frequency Response as an ancillary service in the market. Just as generators can be compensated for frequency regulation, compensation from an ancillary service in an electric energy market can be a method for incentivizing the supply of Frequency Response. As the Commission has noted, in the Regional Transmission Organization (“RTO”) and Independent System Operator (“ISO”) markets, compensation for frequency regulation is based on a number of components, including consideration for capacity set aside to provide the service.<sup>33</sup> When there are financial considerations that conflict with reliability objectives, the reliability process can be compromised or otherwise made more difficult to achieve.

There is a need for appropriate entities in the industry to understand the importance of Frequency Response and for an investigation of various alternatives to ensure that an adequate level of Frequency Response is maintained. For these reasons, NERC continues to support simultaneous efforts with FERC and the industry to maintain and improve Frequency Response in each of the interconnections and encourages FERC to evaluate a market solution as a complement to a Frequency Response Reliability Standard and to consider the benefits of such a comprehensive approach.

#### **E. ERCOT as a Frequency Response Model**

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

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<sup>33</sup> See e.g., *Frequency Regulation Compensation in the Organized Wholesale Power Markets*, Order No. 755, 137 FERC ¶ 61,064 (2011), *order on reh’g*, 138 FERC ¶ 61,123 (2012).

Response have been 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 has evaluated these lessons learned in developing the Frequency Response 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.<sup>34</sup>

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. Six regional entities are responsible for coordinating and promoting bulk electric system reliability in the Eastern Interconnection: the Florida Reliability Coordinating Council, the Midwest Reliability Organization, the Northeast Power Coordinating Council, Inc., the Reliability *First* Corporation, the SERC Reliability Corporation, and the Southwest Power Pool, Inc.<sup>35</sup>

The technology in ERCOT surpasses the technology generally implemented in the remaining portions of the United States. ERCOT implemented a new single Energy

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<sup>34</sup> 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).

<sup>35</sup> See <http://www.nerc.com/page.php?cid=1%7C9%7C119>.

Management System when it merged all companies in the interconnection into a single Balancing Authority.<sup>36</sup> The new SCADA system utilizes a two-second scan rate. This two-second scan rate allows ERCOT to better measure Frequency Response in the ERCOT interconnection than can be done in other Balancing Authorities where scan rates vary from two to six seconds. It is not practical to change out all of the longer scan-rate SCADA systems in North America to achieve two-second scan rates. This is unlikely to occur in the timeframe identified earlier and would require substantial investment, which NERC is prohibited from compelling by Section 215 of the FPA. New technology such as PMUs are currently being installed by various utilities pursuant to Department of Energy grants, but there are only a few hundreds of those devices in service in North America, far too few to properly measure both Net Actual Interchange on all tie-lines and the primary Frequency Response of all generators during a frequency event. The problem of measuring Net Actual Interchange is greatly simplified for ERCOT since they only have two DC ties with other Balancing Authorities.

### **III. DEVELOPMENT OF THE FREQUENCY RESPONSE RELIABILITY STANDARD, BAL-003**

The Frequency Response Standard Drafting Team is currently 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, Terry Bilke, Director of Standards and Compliance 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>37</sup> Sydney Niemeyer, a Control System Specialist at NRG Texas, LP, Michael

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<sup>36</sup> See <http://nodal.ercot.com/about/projects/ems/index.html>.

<sup>37</sup> See e.g., Illian, H. (2010), *Frequency Control Performance Measurement and Requirements*, LBNL-2145E, Ernest Orlando Lawrence Berkeley National Laboratory; available at:

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>38</sup> A roster of the current Frequency Response Standard Drafting Team is included herein as **Attachment C** and a table of activities related to the development of BAL-003-1 is provided as **Attachment D**.

In 2010, the Standard Drafting Team held nine meetings and/or conference calls. *See Attachments D and E*. In 2011, the Standard Drafting Team held thirteen meetings and/or conference calls and two industry webinars. *See Attachments D and F*. In 2012, the Standard Drafting Team has held six meetings and/or conference calls to date. In addition, several technical papers have been published in recent years. *See Attachment G*.

A draft of BAL-003-1 was posted for a 30-day public comment period from February 4, 2011 through March 7, 2011. There were 36 sets of comments, including comments from more than 139 different people from approximately 86 companies.<sup>39</sup> Based on the comments received the drafting team made the following changes to the proposed standard:

- Removed the Single Event Frequency Response Data (SEFRD) definition from the standard.
- Modified the definitions for Frequency Response Measure (FRM) and Frequency Response Obligation (FRO).
- Modified the proposed definition of Frequency Bias Setting.
- Modified FRS Form 1 to correct errors, allow for adjustments and provide clarity.
- Separated Attachment A Background Document into two documents; 1) Attachment A – Supporting Document detailing the methodology to be followed

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<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>38</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>.

<sup>39</sup> See [http://www.nerc.com/docs/standards/sar/Project\\_2007-12\\_Draft\\_1\\_Comment\\_Report-100711.pdf](http://www.nerc.com/docs/standards/sar/Project_2007-12_Draft_1_Comment_Report-100711.pdf).

for calculations, and 2) Background Document detailing the rationale for the development of the requirements.

- Created Attachment B – Process for Adjusting Bias Setting Floor to clarify the methodology to be used in reducing the present 1% minimum Frequency Bias Setting.
- Added measures, VRFs and VSLs.

From October 25, 2011 to December 9, 2011, NERC held a second formal 45-day comment period on BAL-003. There were 43 sets of comments, including comments from approximately 133 different people from approximately 86 companies.

Based on the comments received and the drafting team's discussion of those comments, the drafting team made the following changes to the proposed standard, definitions, and associated documents:

- Modified the definition for Frequency Response Measure (FRM).
- Modified the definition of Frequency Bias Setting.
- Removed the references to Reserve Sharing Groups (RSGs) and replaced them with Frequency Response Sharing Group.
- Created a definition for Frequency Response Sharing Group (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.
- Removed Requirement R5 and combined it into revised Requirement R2 and new Requirement R3.
- Modified Attachment A to provide additional clarity.
- Modified Attachment B to provide additional clarity.
- Made conforming changes to Measures, Evidence Retention, and VSLs to align with language in the revised requirements.
- Re-wrote the Background Document to incorporate additional language for justification of requirements and provide additional clarity.

From November 29, 2011 to December 9, 2011, an initial ballot was held on the Frequency Response standard. From a ballot pool of 362 votes, the measure received 340 total votes for a quorum of 93.92%.<sup>40</sup> However, the ballot received only a 30.83% approval rating.

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<sup>40</sup> See [http://www.nerc.com/docs/standards/sar/Standards\\_Announcement\\_2007-12\\_FR\\_121611final.pdf](http://www.nerc.com/docs/standards/sar/Standards_Announcement_2007-12_FR_121611final.pdf).

Given this low approval rating, NERC Staff predicts that significant efforts to educate the industry will be necessary in order to build the required consensus for a successful ballot.

#### **IV. TECHNICAL CONFERENCES**

NERC proposes to hold two technical conferences in order to educate the industry regarding Frequency Response and the proposed revisions to BAL-003 to build the required consensus required for industry approval of the standard. The first conference will be held on or about May 22, 2012 on the East Coast and the second on or about May 24, 2012 toward the West Coast, in order to maximize possible attendance. A draft technical conference agenda is included for informational purposes as **Attachment A**.

The conferences will address several key issues, including: (1) The need for a Frequency Response standard; (2) An Explanation of the Current Version of BAL-003-1; (3) Measurement of Frequency Response, (including the use of the median as the measure of individual Balancing Authority Performance); (4) Measurement noise (*i.e.*, single event vs. multiple event analysis); (5) Interaction between Frequency Response and Frequency Bias and the proposal to reduce the minimum Frequency Bias setting obligation; and (6) the Contingency Protection Criterion.

#### **V. MOTION FOR EXTENSION**

By this motion, NERC is requesting an extension of time to address the directive in Order No. 693 and the subsequent directives included in the March 18 Order to develop a modification to the BAL-003-0 - Frequency Response and Bias standard. The proposed technical conferences described herein are a necessary component to the development of a revised standard.

Contemporaneously with the technical conferences, the Standard Drafting Team will be conducting additional statistical analysis related to the calculation of the Frequency Response Obligation. Following the technical conferences, NERC will provide for a 30 day comment

period to allow comments on the revised draft BAL-003 Reliability Standard. NERC proposes to file a revised timeline for completing the revisions to BAL-003 with the Commission no later than 21 days following the end of the comment period. This period of time will allow NERC and the Standard Drafting Team to complete necessary research, gain support for the current draft of the standard and will allow for input from both the industry and the Commission.

NERC also proposes to make informational filings with the Commission on a quarterly basis to keep the Commission informed of its continual progress with respect to this issue, following the May technical conferences. As illustrated above, the decline of Frequency Response poses no immediate threat to reliability and has arrested somewhat as a result of the attention brought to bear on this issue by NERC's data requests. For this reason, the instant request for an extension of time poses no threat to reliability.

As outlined above, Frequency Response is a complicated and evolving issue with both technological and economic aspects. NERC has been working diligently within the bounds of its authorities to revise the BAL-003 Reliability Standard to properly address the decline of Frequency Response in a reliability preserving way without imposing unnecessary measures at a cost to industry. NERC believes that it is in the interest of all parties to put forth the most effective Reliability Standard, rather than developing a standard that will later require interpretations in order to be effective and/or accepted by the electric industry.

For these reasons, NERC respectfully requests that the Commission accept this technical opinion and that additional time necessary to properly implement the Commission directives in Order No. 693 with respect to BAL-003 be granted.



## **VI. ATTACHMENTS**

- Attachment A: Draft Technical Conference Agenda
- Attachment B: Draft of Background Document on Development, Testing and Implementation of BAL-003-1
- Attachment C: Frequency Response Standard Drafting Team Roster
- Attachment D: Table of Frequency Response Activities, Development of BAL-003-1
- Attachment E: Frequency Response Standard Drafting Team Meeting Minutes, 2010
- Attachment F: Frequency Response Standard Drafting Team Meeting Minutes, 2011
- Attachment G: Frequency Response Standard Drafting Team Meeting Minutes, 2012

## VII. CONCLUSION

WHEREFORE, in consideration of the foregoing, NERC respectfully requests that an extension of time be granted as set forth herein.

Respectfully submitted,

/s/ Stacey Tyrewala

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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 30th day of March, 2012.

*/s/ Stacey Tyrewala*  
Stacey Tyrewala  
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## **Attachment A**

### **Draft Technical Conference Agenda**

**BAL-003-1**  
**Frequency Response and Frequency Bias Setting Standard**  
**DRAFT Technical Conference Agenda**

**I. THE NEED FOR A FREQUENCY RESPONSE STANDARD**

- FERC Order No. 693 Directives
  - 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 balancing authority with methods of obtaining and measuring that the frequency response is achieved.
- Frequency Response Decline
- Frequency Response in ERCOT

**II. EXPLANATION OF THE CURRENT VERSION OF BAL-003-1**

- Changes made to address Industry concerns

**III. THE BALANCING AUTHORITY AS THE RESPONSIBLE ENTITY FOR FREQUENCY RESPONSE**

**IV. MEASUREMENT OF FREQUENCY RESPONSE**

- Mean/Median/Regression analysis
- Recognition of current limitations on measurements
  - Cannot measure Point C for Balancing Authorities
  - Scan rate
- Measurement “Noise” (Single event v. Multiple event)
  - Measurement of compliance for a single event cannot be achieved and would result in certain failure for all Balancing Authorities in a multiple Balancing Authority interconnection

## **V. FREQUENCY RESPONSE AND FREQUENCY BIAS AND THE PROPOSAL TO REDUCE THE MINIMUM FREQUENCY BIAS SETTING OBLIGATION**

### **VI. DETERMINATION OF FREQUENCY RESPONSE OBLIGATIONS**

- Interconnection Frequency response Obligations
  - Contingency protection criterion
  - Reliability margins
- Determination of Balancing Authority Frequency Response Obligations

### **VII. FREQUENCY RESPONSE IN AN ENERGY MARKET**

- Frequency Response as an ancillary service

**Attachment B**

**Draft of Background Document on Development, Testing and  
Implementation of BAL-003-1**

**NERC**

NORTH AMERICAN ELECTRIC  
RELIABILITY CORPORATION

# Frequency Response Standard Background Document

January, 2012

**RELIABILITY | ACCOUNTABILITY**



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## Introduction

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This document provides background on the development, testing and implementation of BAL-003-1 - Frequency Response Standard (FRS). The intent is to explain the rationale and considerations for the Requirements and their associated compliance information. The document also provides good practices and tips for Balancing Authorities with regard to Frequency Response.

In Order No. 693, the FERC directed additional changes to BAL-003-0.1b. This document explains how those directives are met by BAL-003-1.

The original Standards Authorization Request (SAR), finalized on June 30, 2007, assumed there was adequate Frequency Response in all the North American Interconnections. The goal of the SAR was to update the Standard to make the measurement process more objective and to provide this objective data to Planners and Operators for improved modeling. The improved models will improve understanding of the trends in Frequency Response to determine if reliability limits were being approached. The Standard would also lay the process groundwork for a transition to a performance-based Standard if reliability limits were approached.

This document will be periodically updated by the FRS Drafting Team until the Standard is approved. Once approved, this document will then be maintained and updated by the ERO and the NERC Resources Subcommittee to be used as a reference and training resource.

## Background

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Most system operators have a good general understanding of frequency control and Bias Setting as outlined in the balancing standards and the references in the [NERC Operating Manual](#). This section discusses the different components of frequency control. Frequency control can be divided into four overlapping windows of time as outlined below.

**Primary Frequency Control (Frequency Response)** – Actions provided by the Interconnection to arrest and stabilize frequency in response to frequency deviations. Primary Control comes from automatic generator governor response, load response (typically from motors), and other devices that provide an immediate response based on local (device-level) control systems.

**Secondary Frequency Control** – Actions provided by an individual BA or its Reserve Sharing Group to correct the resource – load unbalance that created the original frequency deviation, which will restore both Scheduled Frequency and Primary Frequency Response. Secondary Control comes from either manual or automated dispatch from a centralized control system.

**Tertiary Frequency Control** – Actions provided by Balancing Authorities on a balanced basis that are coordinated so there is a net zero effect on ACE. Examples of Tertiary Control include dispatching generation to serve native load; economic dispatch; dispatching generation to affect Interchange; and re-dispatching generation. Tertiary Control actions are intended to replace Secondary Control Response by reconfiguring reserves.

**Time Control** includes small offsets to scheduled frequency to keep long term average frequency at 60 Hz.

**Primary Frequency Response** is the first stage of overall frequency control and is the response of resources and load to a locally sensed change in frequency to arrest that change in frequency. Primary Frequency Response is automatic and is not driven by any centralized system and begins within seconds rather than minutes. Different resources, loads, and systems provide Primary Frequency Response with different response times, based on current system conditions such as total resource/load and their respective mix.

The NERC Glossary of Terms defines **Frequency Response** as:

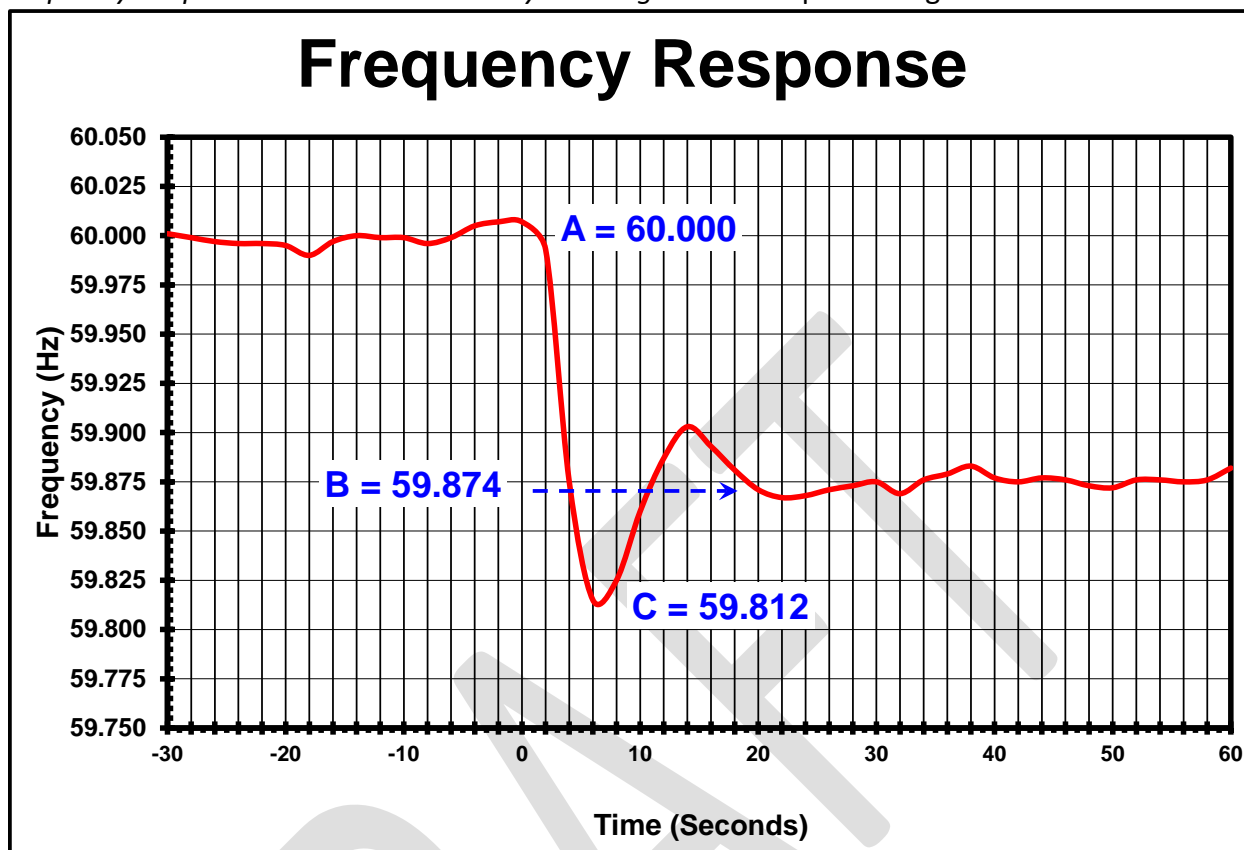
- (Equipment) The ability of a system or elements of the system to react or respond to a change in system frequency.
- (System) The sum of the change in demand, plus the change in generation, divided by the change in frequency, expressed in megawatts per 0.1 Hertz (MW/0.1 Hz).

As noted above, Frequency Response is the characteristic of load and generation within Balancing Authorities and Interconnections that reacts or responds to changes in load-resource balance. Because the loss of a large generator is much more likely than a sudden loss of an equivalent amount of load, Frequency Response is typically discussed in the context of a loss of a large generator.

The classic Frequency Response points A, C, and B, shown in Fig. 1 Frequency Response Characteristic, are used for this measurement as found in the Frequency Response Characteristic Survey Training Document within the NERC operating manual, whose most recent copy can be found at [http://www.nerc.com/files/opman\\_7-1-11.pdf](http://www.nerc.com/files/opman_7-1-11.pdf). This traditional Frequency Response measure has recently been more specifically named **Settled Frequency Response**. Settled Frequency Response has been used because it provides the best Frequency Response measure to estimate the Frequency Bias Setting in Tie-line Bias Control based Automatic Generation Control Systems. However, the industry has recognized that there is considerable variability in measurement resulting from the selection of Point A and Point B in the traditional measure making the traditional measurement method unsuitable as the basis for an enforceable reliability standard in the real world setting of multiple Balancing Authority interconnections.

Measuring an Interconnection's Frequency Response is straightforward and fairly accurate. All that's needed to make the calculation is to know the size of a given contingency (MW), divide this value by the change in frequency and multiply the results by 10 since frequency response is expressed in MW/0.1Hz.

Measuring a BA's frequency response is more challenging. Prior to BAL-003-1, NERC's *Frequency Response Characteristic Survey Training Document* provided guidance to calculate



Frequency Response. In short, it told the reader to identify the BA's interchange values "immediately before" and "immediately after" the disturbance and use the difference to calculate the MWs the BA deployed for the event. There are two challenges with this approach:

- Two people looking at the same data would come up with different values when assessing which exact points were immediately before and after the excursion.
- In practice, the actual response provided by the BA can change significantly in the window of time between point B and when secondary and tertiary control can assist in recovery.

Therefore, the measurement of Settled Frequency Response has been standardized in a number of ways to limit the variability in measurement resulting from the poorly specified selection of Point A and Point B. It should be noted that t-0 has been defined as the first scan value that shows a deviation in frequency of some significance, usually approaching about 10 mHz. The goal is such that the first scan prior to t-0 was unaffected by the deviation and appropriate for one of the averaging points.

- The A-value averaging period of approximately the previous 16 seconds prior to t-0 was selected to allow for an averaging of at least 2 scans for entities utilizing 6 second scan rates. (all time average period references are for 2 second scan rates.)
- The B-value averaging period of approximately (t+20 to t+52 seconds) was selected to attempt to obtain the average of the data after primary frequency response was deployed and the transient completed(settled), but before significance influence of secondary control. Multiple periods were considered for averaging the B-value:
  - 12 to 24 sec
  - 18 to 30 sec
  - 20 to 40 sec
  - 18 to 52 sec
  - 20 to 52 sec

It is necessary for all BAs from an interconnection to use the same averaging periods to provide consistent results. In addition, the SDT decided that until more experience is gained, it is also desirable for all interconnections to use the same averaging periods to allow comparison between interconnections.

The methods presented in this document only address the values required to calculate the frequency response associated with the frequency change between the initial frequency, A-Value, and the settling frequency, B-Value. No reasonable or consistent calculations can be made related to the arresting frequency, C-Value, using EMS scan rate data as long as 6-seconds or tie-line flow values associated with the minimum value of the frequency response characteristic (C-value) as measured at the BA level.

Both the calculation of the Frequency at Point A and the Frequency at Point B began with the assumption that a 6-second scan rate was the source of the data. Once the averaging periods for a 6-second scan rate were selected, the averaging periods for the other scan rates were selected to provide as much consistency as possible between BAs with different scan rates.

The Frequency at Point A was initially defined as the average of the two scans immediately prior to the frequency event. All other averaging periods were selected to be as consistent as possible with this 12 second average scan from the 6-second scan rate method. In addition, the Actual Net Interchange Immediately Before Disturbance is defined as the average of the same scans as used for the Point A frequency average.

The Frequency at Point B was then selected to be an average as long as the average of 6-second scan data as possible that would not begin until most of the hydro governor response had been delivered and would end before significant AGC recovery response had been initiated as indicated by a consistent frequency restoration slope. The Actual Net Interchange Immediately After Disturbance is defined as the average of the same scans as used for the Point B frequency average.

### **B Averaging Period Selection:**

Experience from ERCOT and the field trail on other interconnections indicated that the 12 to 24 second and 18 to 30 second averaging periods were not suitable because they did not provide the consistency in results that the other averaging periods provided, and

that the remaining measuring periods do not provide significantly different results from each other. The team believed that this was observed because the transients were not complete in all of the samples using these averaging periods.

The 18 to 52 second and 20 to 52 second averaging periods were compared to each other, with the 20 to 52 second period providing more consistent values, believed to result from the incomplete transient in some of the 18 to 52 second samples.

This left a choice between the 20 to 40 second and the 20 to 52 second averaging periods. The team recognized that there would be more AGC response in the 20 to 52 second period, but the team also recognized that the 20 to 52 second period would provide a better measure of squelched response from outer loop control action. The 20 to 52 second period was selected because it would indicate squelched response from outer-loop control and provide incentive to reduce response withdrawal. The final selections for the data averaging periods used in FRS Form 1 are shown in the table below.

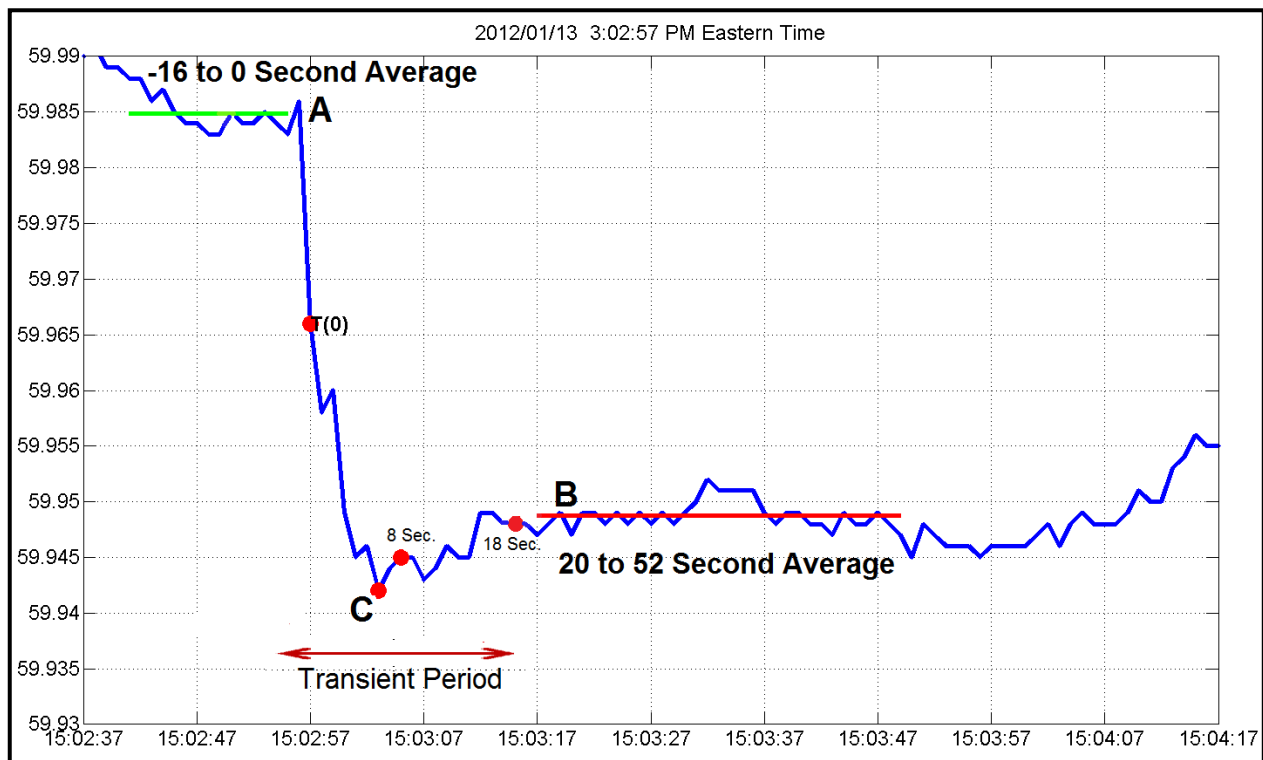
<b>Definitions of Frequency Values for Frequency Response Calculation</b>			
<b>Scan Rate</b>	<b>T 0 Scan</b>	<b>A Value (average)</b>	<b>B Value (average)</b>
<b>6-Seconds</b>	<b>Identify first significant change in frequency as the T 0 scan</b>	<b>Average of T-1 through T-2 scans</b>	<b>Average of T+4 through T+8 scans</b>
<b>5-Seconds</b>		<b>Average of T-1 through T-2 scans</b>	<b>Average of T+5 through T+10 scans</b>
<b>4-Seconds</b>		<b>Average of T-1 through T-3 scans</b>	<b>Average of T+6 through T+12 scans</b>
<b>3-Seconds</b>		<b>Average of T-1 through T-5 scans</b>	<b>Average of T+7 through T+17 scans</b>
<b>2-Seconds</b>		<b>Average of T-1 through T-8 scans</b>	<b>Average of T+10 through T+26 scans</b>

Consistent measurement of Primary Frequency Response is achievable for a selected number of events and can produce representative frequency response values, provided an appropriate sample size is used in the analysis. Available research investigating the minimum sample size to provide consistent measurements of Frequency Response has shown that a minimum sample size of 20 events should be adequate.

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 current methods. In addition, the number of an interconnection's resources and loads providing their response could be problematic when compiling results for multiple events.

Measurement of Primary Frequency Response on an interconnection (System) basis is straight forward provided that an accurate frequency metering source is available and the magnitude of the resource/load imbalance is known in MWs.

Measurement on a Balancing Authority basis can be a challenge, since the determination of change in MWs is determined by the change in the individual BA's metered tie lines. Summation of tie lines is accomplished by summing the results of values obtained by the digital scanning of meters at intervals up to six seconds, resulting in a non-coincidental summing of values. Until the technology to GPS time stamp tie line values at the meter and the summing of



**Figure 2. Frequency Response Measurement**

those values for coincidental times is in use throughout the industry, it is necessary to use averaging of values described above to obtain consistent results.

The standardized measure is shown graphically in Fig. 2 Frequency Response Measurement with the averaging periods shown by the solid blue lines on the graph. Since the FERC directed a performance obligation for BAL-003-1, it is important to be more objective in the measurement process. The standardized calculation is available on FRS Form 2 for scan rates of 2, 3, 4, 5, and 6 seconds at [http://www.nerc.com/filez/standards/Frequency\\_Response.html](http://www.nerc.com/filez/standards/Frequency_Response.html).

### **Arrested Frequency Response**

There is another measure of Frequency Response of interest when developing a Frequency Response estimate that not only will be used for estimating the Frequency Bias Setting; but, will also be used to assure reliability by operating in a manner that will bound interconnection frequency and prevent the operation of Under-frequency Relays. This Frequency Response measure has recently been named Arrested Frequency Response. This Frequency Response is significantly affected by the Inertial Frequency Response, the Governor Frequency Response and the time delays associated with the delivery of Governor Frequency Response. It is calculated by using the change in Frequency between the initial frequency, A, and the maximum frequency change during the event, C, instead of using the change between A and B. Arrested Frequency Response is the correct response for determining the minimum Frequency Response related to under-frequency relay operation and the support of interconnection reliability. This is because it can be used to provide a direct estimate of the maximum frequency deviation an interconnection will experience for an initial frequency and a given size event in MW. Unfortunately, Arrested Frequency Response cannot currently be measured using the existing measurement infrastructure. This limitation exists because the scan rates

currently used in industry EMSs are incapable of measuring the Net Actual Interchange at the same instant that the maximum frequency deviation is reached. Fortunately, the ratio of Arrested Frequency Response and Settled Frequency Response tends to be stable on an interconnection. This allows the Settled Frequency Response value to be used as a surrogate for the Arrested Frequency Response and implement a reasonable measure upon which to base a standard. One consequence of using the Settled Frequency Response as a surrogate for the Arrested Frequency Response is the inclusion of a large Reliability Margin in Interconnection Frequency Response Obligation to allow for the difference between the Settled Frequency Response as measured and the Arrested Frequency Response that indicates reliability.

As measurement infrastructure improves one might expect the Frequency Response Obligation to transition to a measurement based directly on the Arrested Frequency Response while the Frequency Bias Setting will continue to be based on the Settled Frequency Response. However, at this time, the measurement devices and methods in use do not support the necessary level of accuracy to estimate Arrested Frequency Response contribution for an individual Balancing Authority.

## Rationale by Requirement

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### Requirement 1

*R1. Each Balancing Authority or Frequency Response Sharing Group (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 Balancing Authority or FRSG to maintain an adequate level of Frequency Response in the Interconnection.*

### *Background and Rationale*

R1 is intended to meet the following primary objectives:

- Determine whether a Balancing Authority (BA) has sufficient Frequency Response for reliable operations.
- Provide the feeder information needed to calculate CPS limits and Frequency Bias Settings.

### **Primary Objective**

With regard to the first objective, FRS Form 1 and the process in Attachment A provide the method for determining the Interconnections' necessary amount of Frequency Response and allocating it to the Balancing Authorities. The field trial for BAL-003-1 is testing an allocation methodology based on the amount of load and generation in the BA. This is to accommodate the wide spectrum of BAs from generation-only all the way to load-only.

### **Frequency Response Sharing Groups (FRSGs)**

This standard proposes an entity called FRSG, which is defined as:



*A group of two or more Balancing Authorities, that collectively maintain, allocate, and supply operating resources required to jointly meet the Frequency Response Standard.*

This standard allows Balancing Authorities to cooperatively form FRSGs as a means to jointly meet the FRS. There is no obligation to form or be a part of FRSGs. The members of the FRSG would determine how to allocate sanctions among its members. This standard does not mandate the formation of FRSGs, but allows them as a means to meet one of the FERC's Order No. 693 directives.

FRSG performance may be calculated one of two ways:

- Calculate a group NI<sub>A</sub> and measure the group response to all events in the reporting year on a single FRS Form 1, or
- Jointly submit the individual BAs' Form 1s, with a summary spreadsheet that sums each participant's individual event performance.

### **Frequency Response Obligation and Calculation**

The basic Frequency Response Obligation is based on non-coincident peak load and generation data reported in FERC Form 714 (where applicable, see below for non-jurisdictional entities) for the previous full calendar year. The basic allocation formula used by NERC is:

$$FRO_{BA} = FRO_{Int} \times \frac{\text{Peak Gen}_{BA} + \text{Peak Load}_{BA}}{\text{Peak Gen}_{Int} + \text{Peak Load}_{Int}}$$

Where:

- Peak Gen<sub>BA</sub> is the average of monthly "Output of Generating Plants", FERC Form 714, column f of Part II - Schedule 3.
- Peak Load<sub>BA</sub> is the average of "Monthly Peak Demand (MW)", FERC Form 714, column j of Part II - Schedule 3.
- Peak Gen<sub>Int</sub> is the sum of all Peak Gen<sub>BA</sub> values reported in that interconnection.
- Peak Load<sub>Int</sub> is the sum of all Peak Load<sub>BA</sub> values reported in that interconnection.

Balancing Authorities that are not FERC jurisdictional should use the [Form 714 Instructions](#) to assemble and submit equivalent data. Until the BAL-003-1 process outlined in Attachment 1 is implemented, Balancing Authorities can approximate their FRO by multiplying their Interconnection's FRO by their share of Interconnection Bias. The data used for this calculation should be for the most recently filed Form 714. As an example, a report to NERC in January 2013 would use the Form 714 data filed in 2012, which utilized data from 2011.

Balancing Authorities that merge or that transfer load or generation need to notify the ERO of the change in footprint and corresponding changes in allocation such that the net obligation for the Interconnection remains the same and so that CPS limits can be adjusted.

Attachment A proposes the following Interconnection event criteria as a basis to determine an Interconnection's Frequency Response Obligation:

- Largest category C loss-of-resource (N-2) event.
- Largest total generating plant with common voltage switchyard.
- Largest loss of generation in the interconnection in the last 10 years.

Given the fact that the Interconnections currently have sufficient Frequency Response, few BAs should encounter problems meeting R1, particularly with the options the Standard provides with regard to obtaining Frequency Response.

With regard to the second objective above (determining Frequency Bias Settings and CPS limits), Balancing Authorities have been asked to perform annual reviews of their Frequency Bias Settings by measuring their Frequency Response, dating back to Policy 1. This obligation was carried forward into BAL-003-01.b. While the associated training document provided useful information, it left many of the details to the judgment of the person doing the analysis. The FRS Form 1 and FRS Form 2 provide a consistent, objective process for calculating Frequency Response to develop an annual measure, the FRM.

The FRM will be computed from Single Event Frequency Response Data (SEFRD), defined as: "the data from an individual event from a Balancing Authority that is used to calculate its Frequency Response, expressed in MW/0.1Hz". The SEFRD for a typical Balancing Authority in an Interconnection with more than one Balancing Authority is basically the change of its Net Actual Interchange on its tie lines with its adjacent Balancing Authorities divided by the change in Interconnection frequency. (Some Balancing Authorities may choose to apply corrections to their Net Actual Interchange values to account for factors such as nonconforming loads. FRS Form 1 shows the types of adjustments that are allowed.)

A standardized sampling interval of approximately 20 to 52 seconds will be used in the computation of SEFRD values. Microsoft Excel® spreadsheet interfaces for EMS scan rates of 2 through 6 seconds will be provided to support the computation.

In an attempt to balance the workload of Balancing Authorities with the need for accuracy in the FRM, the field trial will require at least 20 samples selected during the course of the year to compute the FRM. Research conducted by the Frequency Response Standard Drafting Team (FRSDT) indicated that a Balancing Authority's FRM will converge to a reasonably stable value with at least 20 samples.

### **Median as the Standard's Measure of Balancing Authority Performance**

The FRSDT evaluated different approaches for "averaging" individual event observations to compute a technically sound estimate of Frequency Response Measure (FRM). 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 east may only be called on to contribute 10MW for the loss of a 1000MW. The 10 MW of governor and load response may easily be masked as a coincident change in load.

In general, statisticians use the median as the best measure of central tendency when a population has outliers. Two independent reviews by the FRSDT has shown the Median to be less influenced by noise in the measurement process and the team has chosen the median as the initial metric for calculating the BAs’ Frequency Response Measure.

The Frequency Responsive Reserve Standard Drafting Team (FRSDT) performed extensive empirical studies and engaged in lively discussions in an attempt to determine the best aggregation technique for a sample set size of at least 20 events. Mean, median, and linear regression techniques were used on a trial basis with the data that was available during the early phases of the effort.

A key characteristic of the “aggregation challenge” is related to the use of actual net interchange data for measuring frequency response. The tie line flow measurements are varying continuously due to other operational phenomena occurring concurrently with the provision of frequency response. (See Appendix 1 for details.) All samples have noise in them, as most operational personnel who have computed the frequency response of their Balancing Authority can attest. What has also become apparent to the FRSDT is that while the majority of the frequency response samples have similar levels of noise in them, a few of the samples may have much larger errors in them than the others that result in unrepresentative results. And with the sample set size of interest, it is common to have unrepresentative errors in these few samples to be very large and asymmetric. For example, one Balancing Authority’s subject matter expert observed recently that 4 out of 31 samples had a much larger error contribution than the other 27 samples, and that 3 out of 4 of the very high error samples grossly underestimated the frequency response. The median value demonstrated greater resiliency to this data quality problem than the mean with this data set. (The median has also demonstrated superiority to linear regression in the presence of these described data quality problems in other analyses conducted by the FRRSDT, but the linear regression showed better performance than the mean.)

The above can be demonstrated with a relatively simple example. Let’s assume that a Balancing Authority’s true frequency response has an average value of -200 MW/ .1 Hz. Let’s also assume that this Balancing Authority installed “special” perfect metering on key loads and generators, so that we could know the true frequency response of each sample. And then we will compare them with that measured by typical tie line flow metering, with the kind of noise and error that occurs commonly and “not so commonly”. Let’s start with the following 4 samples having a common level of noise, with MW/ .1 Hz as the unit of measurement.

Perfect measurement	noise	Samples from tie lines
-190	-30	-220
-210	-20	-230
-220	10	-210
-180	20	-160
-200	Mean	-205
-200	Median	-215

Now let’s add a fifth sample, which is highly contaminated with noise and error that grossly underestimates frequency response.

Perfect measurement	noise	Samples from tie lines
-190	-30	-220

-210	-20	-230
-220	10	-210
-180	20	-160
-200	250	+50
-200	Mean	-154
-200	Median	-210

It is clear from the above simplistic example that the mean drops by about 25% while the median is affected minimally by the single highly contaminated value.

Based on the analyses performed thus far, the FRRSDT 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 FRRSDT sees merit and promise in future research with sample filtering combined with a technique such as linear regression.

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. 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.

However, linear regression does not provide a better method when dealing with a few samples with large magnitudes of noise and unrepresentative error. There are only two alternatives to improve over the use of median when dealing with these larger unrepresentative errors:

1. Increase the sample size, or
2. Actively eliminate outliers due to unrepresentative error.

Unfortunately, the first alternative, increasing the sample size is not available because significantly more sample events are not available within the measurement time period of one year. Linear regression techniques are being investigated that have an active outlier elimination algorithm that would eliminate data that lie outside ranges of the 96th percentile and 99th percentile, for example.

Still, the use of linear regression has value in the context of this standard. The Resources Subcommittee will use linear regression to evaluate Interconnection frequency response, particularly to evaluate trends, seasonal impacts, time of day influences, etc.. The Good Practices and Tools section of this document outlines how a BA can use linear regression to develop a predictive tool for its operators.

Additional discussion on this topic is contained in “Appendix 1 – Data Quality Concerns Related to the Use of Actual Net Interchange Value” of this document.

### **Sample Size**

In order to support field trial evaluations of sample size, sampling intervals, and aggregation techniques, the FRRSDT will be retrieving scan rate data from the Balancing Authorities for each SEFRD. Additional frequency events may also be requested for research purposes, though they will not be included in the FRM computation.

FERC Order No. 693 directed the ERO to define the number of Frequency Response surveys that were conducted each year and to define a necessary amount of Frequency Response. R1 addresses both of these directives:

- There is a single annual survey of at least 20 events each year.
- The FRM calculated on FRS Form 1 is compared by the ERO against the FRO determined 12 months earlier (when the last FRS Form 1 was submitted) to verify the Balancing Authority provided its share of Interconnection Frequency Response.

FERC Order No. 693 also directed the Standard should identify methods for Balancing Authorities to obtain Frequency Response. Requirement R1 allows Balancing Authorities to participate in Frequency Response Sharing Groups (FRSGs) to provide or obtain Frequency Response. These may be the same FRSGs that cooperate for BAL-002-0 or may be FRSGs that form for the purposes of BAL-003-1.

If BAs participate as an FRSG for BAL-003-1, compliance is based on the sum of the participants' performance.

Two other ways that BAs could obtain Frequency Response are through Supplemental Service or Overlap Regulation Service:

- No special action is needed if a BA provides or receives supplemental regulation. If the regulation occurs via Pseudo Tie, the transfer occurs automatically as part of Net Actual Interchange (NIA) and in response to information transferred from recipient to provider.
- If a BA provides overlap regulation, its FRS Form 1 will include the Frequency Bias setting as well as peak load and generation of the combined Balancing Authority Areas. The FRM event data will be calculated on the sum of the provider's and recipient's performance.

In the Violation Severity Levels for Requirement R1, the impact of a BA not having enough frequency response depends on two factors:

- Does the Interconnection have sufficient response?
- How short is the BA in providing its FRO?

The VSL takes these factors into account. While the VSLs look different than some other standards, an explanation would be helpful.

VSLs are a starting point for the enforcement process. The combination of the VSL and VRF is intended to measure a violation's impact on reliability and thus levy an appropriate sanction. Frequency Response is an interconnection-wide resource. The proposed VSLs are intended to put multi-BA Interconnections on the same plain as single-BA Interconnections.

Consider a small BA that whose performance is 70% of its FRO. If all other BAs in the Interconnection are compliant, the small BA's performance has negligible impact on reliability, yet would be sanctioned at the same level as a BA who was responsible for its entire Interconnection. It is not rational to sanction this BA the same as a single BA Interconnection

that had insufficient Frequency Response. To do otherwise would treat multi-BA Interconnections tens of times more harshly than single BA Interconnections.

The “Lower” and “Medium” VSLs say that the Interconnection has sufficient Frequency Response but individual BAs are deficient by small or larger amounts respectively. The High and Severe VSLs say the Interconnection does not meet the FRO and assesses sanctions based on whether the BA is deficient by a small or larger amount respectively.

## Requirement 2

*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 subject to 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 to ensure effectively coordinated Tie Line Bias control.*

### *Background and Rationale*

Attachment A of the Standard discusses the process the ERO will follow to validate the BA’s FRS Form 1 data and publish the official Frequency Bias Settings. Historically, it has taken multiple rounds of validation and outreach to confirm each BA’s data due to transcription errors, misunderstanding of instructions, and other issues. While BAs historically submit Bias Setting data by January 1, it often takes one or more months to complete the process.

The target is to have BAs submit their data by January 10. The BAs are given 30 days to assemble their data since the BAs are dependent on the ERO to provide them with FRS Form 1, and there may be process delays in distributing the forms since they rely on identification of frequency events through November 30 of the preceding year.

Frequency Bias Settings generally change little from year to year. Given the fact that BAs can encounter staffing or EMS change issues coincident with the date the ERO sets for new Frequency Bias Setting implementation, the standard provides a 24 hour window on each side of the target date.

To recap the annual process:

1. The ERO posts the official list of frequency events to be used for this Standard 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 1<sup>st</sup> of each year.

BAL-003-0.1b standard requires a minimum Frequency Bias Setting equal in absolute value to one percent of the Balancing Authority's estimated yearly peak demand (or maximum generation level if native load is not served). For most Balancing Authorities 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 since a larger magnitude response is realized. This is especially true in the Eastern Interconnection where this condition requires excessive secondary frequency control response which degrades overall system performance and increases operating cost as compared to requiring an appropriate balance of primary and secondary frequency control response.

Balancing Authorities were given a minimum Frequency Bias Setting obligation because there had never been a mandatory Frequency Response Obligation. This historic "one percent of peak per 0.1Hz" obligation, dating back to NERC's predecessor, NAPSIC, was intended to ensure all BAs provide some support to Interconnection frequency.

The ideal system control state exists when the Frequency Bias Setting of the Balancing Authority exactly matches the actual Frequency Response characteristic of the Balancing Authority. If this is not achievable, over-bias is significantly better from a control perspective than under-bias with the caveat that Frequency Bias is set relatively close in magnitude to the Balancing Authority actual Frequency Response characteristic. Setting the Frequency Bias to better approximate the Balancing Authority natural Frequency Response characteristic will improve the quality and accuracy of ACE control, CPS & DCS and general AGC System control response. This is the technical basis for recommending an adjustment to the long standing "1% of peak/0.1Hz" Frequency Bias Setting. Attachment B is intended to bring the Balancing Authorities' Frequency Bias Setting closer to their natural Frequency Response. Attachment B balances the following objectives:

- Bring the Frequency Bias Setting and Frequency Response closer together.
- Allow time to analyze impact on other Standards (CPS, BAAL and to a lesser extent DCS) by adjustments in the minimum Frequency Bias Setting, by accommodating only minor adjustments.
- Do not allow the Frequency Bias Setting minimum to drop below natural Frequency Response, because under-biasing could affect an Interconnection adversely.

Additional flexibility has been added to the Frequency Bias Setting based on the actual Frequency Response (FRM) by allowing the Frequency Bias Setting to have a value in the range from 100% of FRM to 125% of FRM. This change has been included for the following reasons:

- When the new standardized measurement method is applied to BAs with a Frequency Response close to the interconnection minimum response, the requirement to use FRM is as likely to result in a Frequency Bias Setting below the actual response as it is to result in a response above the actual response. From a reliability perspective, it is always better to have a Frequency Bias Setting slightly above the actual Frequency Response.
- As with single BA interconnections, the tuning of the control system may require that the BA implement a Frequency Response Setting slightly greater in absolute terms than its actual Frequency Response to get the best performance.
- The new standardized measurement method for determining FRM in some cases results in a measured Frequency Response significantly lower than the previous methods used by some BAs. It is desirable to not require significant change in the Frequency Bias Setting for these BAs that experience a reduction in their measured Frequency Response.

### Requirement 3

*R3. Each Balancing Authority that is a member of a multiple Balancing authority interconnection and is not receiving Overlap Regulation Service and uses a variable Frequency Bias Setting shall have an absolute average Frequency Bias Setting, computed from clock minute samples of its Frequency Bias Setting when the clock minute samples of its Interconnection's frequency is greater than 60.036 Hz or less than 59.964 Hz, that equals or exceeds the greater of the absolute values of its Frequency Response Measure from the previous evaluation period and its Interconnection's minimum as specified in Attachment A.*

#### *Background and Rationale*

In multi-Balancing Authority interconnections, the Frequency Bias Setting should be coordinated among all BAs on 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 Balancing Authority and the ERO can compare this value to the previous year's Frequency Bias Setting minimum to ensure 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.



#### Requirement 4

*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:*

- *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 as shown on FRS Form 1 and FRS Form 2 for the entirety of the participating Balancing Authorities' Areas.*

#### *Background and Rationale*

This requirement reflects the operating principles first established by NERC Policy 1 and is similar to Requirement R6 of the approved BAL-003-0.1b standard. Overlap Regulation Service is a method of providing regulation service in which the Balancing Authority providing the regulation service incorporates another Balancing Authority's actual interchange, frequency response, and schedules into the providing Balancing Authority's AGC/ACE equation.

As noted earlier, a BA that is providing Overlap Regulation will report the sum of the Bias Settings in its FRS Form 1. Balancing Authorities receiving Overlap Regulation Service have an ACE and Frequency Bias Setting equal to zero (0).

# How this Standard Meets the FERC Order 693 Directives

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## FERC Directive

The following is the relevant paragraph of Order No. 693.

*Accordingly, the Commission approves Reliability Standard BAL-003-0 as mandatory and enforceable. In addition, the Commission directs the ERO 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 balancing authority with methods of obtaining and measuring that the frequency response is achieved.*

### 1. Levels of Non-Compliance

VRFs and VSLs are an equally effective way of assigning compliance elements to the standard.

### 2. Determine the appropriate periodicity of frequency response surveys necessary to ensure that Requirement R2 and other Requirements of the Reliability Standard are met

BAL-003 V0 R2 (the basis of Order No. 693) deals with the calculation of Frequency Bias Setting such that it reflects natural Frequency Response.

The drafting team has determined that a sample size on the order of at least 20 events is necessary to have a high confidence in the estimate of a BA's Frequency Response. Selection of the frequency excursion events used for analysis will be done via a method outlined in Attachment A to the Standard.

On average, these events will represent the largest 2-3 "clean" frequency excursions occurring each month.

Since Frequency Bias Setting is an annual obligation, the survey of the at least 20 frequency excursion events will occur once each year.

### 3. Define 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

#### *Necessary Amount of Frequency Response*

The drafting team has proposed the following approach to defining the necessary amount of frequency response. In general, the goal is to avoid triggering the first step of under-frequency load shedding (UFLS) in the given Interconnection for reasonable contingencies expected. The

methodology for determining each Interconnection's and Balancing Authority's obligation is outlined in Attachment A to the Standard.

It should be noted the standard cannot guarantee there will never be a triggering of UFLS as the magnitude of "point C" differs throughout an interconnection during a disturbance and there are local areas that see much wider swings in frequency.

The contingency protection criterion is the largest reasonably expected contingency in the Interconnection. This can be based on the largest observed credible contingency in the previous 10 years or the largest Category C event for the Interconnection.

Attachment A to the standard presents the base obligation by Interconnection and adds a Reliability Margin. The Reliability Margin included addresses the difference between Points B and C and accounts for variables.

For multiple BA interconnections, the Frequency Response Obligation is allocated to BAs based on size. This allocation will be based on the following calculation:

$$FRO_{BA} = FRO_{Int} \times \frac{\text{Peak Gen}_{BA} + \text{Peak Load}_{BA}}{\text{Peak Gen}_{Int} + \text{Peak Load}_{Int}}$$

#### *Methods of Obtaining Frequency Response*

The drafting team believes the following are valid methods of obtaining Frequency Response:

- Regulation services.
- Contractual service. The drafting team has developed an approach to obtain a contractual share of Frequency Response from Adjacent Balancing Authorities. See FRS Form 1. While the final rules with regard to contractual services are being defined, the current expectation is that the ERO and the associated Region(s) should be notified beforehand and that the service be at least 6 months in duration.
- Through a tariff (e.g. Frequency Response and regulation service).
- From generators through an interconnection agreement.
- Contract with an internal resource or loads (The drafting team encourages the development of a NAESB business practice for Frequency Response service for linear (droop) and stepped (e.g. LaaR in Texas) response).

Since NERC standards should not prescribe or preclude any particular market related service, BAs and FRSGs may use whatever is most appropriate for their situation.

#### *Measuring that the Frequency Response is Achieved*

FRS Form 1 and the underlying data retained by the BA will be used for measuring whether Frequency Response was provided. FRS Form 1 will provide the guidance on how to account for and measure Frequency Response.

## Going Beyond the Directive

Based on the combined operating experience of the SDT, the drafting team believes each Interconnection has sufficient Frequency Response. If margins decline, there may be a need for additional standards or tools. The drafting team and the Resources Subcommittee are working with the ERO on its Frequency Response Initiative to develop processes and good practices so the Interconnections are prepared. These good practices and tools are described in the following section.

The drafting team is also evaluating a risk-based approach for basing the Interconnection Frequency Response Obligation on an historic probability density of frequency error, and for allocating the obligation on the basis of the Balancing Authority's average annual ACE share of frequency error. This allocation method uses the inverse of the rationale for allocating the CPS1 epsilon requirement by Bias share.

## Future Work

The drafting team evaluated a proposal on a risk-based approach for basing the Interconnection Frequency Response Obligation on an historic probability density of frequency error, and for allocating the obligation on the basis of the Balancing Authority's average annual ACE share of frequency error. Full evaluation could not be completed in time to support version 1 of BAL-003. Initial information on this approach is posted on the Resources Subcommittee website. Further research on this approach is encouraged.

## Good Practices and Tools

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### Background

This section outlines tips and tools for Balancing Authorities to help them meet the Frequency Response Standard or to operate more reliably. If you have suggested additions, send them to [balancing@nerc.com](mailto:balancing@nerc.com).

#### Identifying and Estimating Frequency Responsive Reserves

Knowing the quantity and depth of frequency responsive reserves in real time is a possible next step to being better prepared for the next event. The challenge in achieving this is having the knowledge of the capabilities of all sources of frequency response. Presently the primary source of frequency response remains with the generation resources in our fleets.

Understanding how each of these sources performs to changes in system frequency and knowing their limitations would improve the BA's ability to measure frequency responsive reserves. Presently there are only guidelines, criteria and protocols in some regions of the industry that identify specific settings and performance expectations of primary frequency response of resources.

One method of gaining better understanding of performance is to measure performance during actual events that occur on the system. Measuring performance during actual events would only provide feedback for performance during that specific event and would not provide insight into depth of response or other limitations.

Repeated measurements will increase confidence in expected performance. NERC modeling standards are in process to be revised that will improve the BA's insight into predicting available frequency responsive reserves. However, knowing how resources are operated, what modes of operation provide sustained primary frequency response and knowing the operating range of this response would give the BA the knowledge to accurately predict frequency response and the amount of frequency responsive reserves available in real time.

Some benefits have been realized by communicating to generation resources (GO) the importance of operating in modes that allow primary frequency response to be sustained by the control systems of the resource. Other improvements in implementation of primary frequency response have been achieved through improved settings on turbine governors through the elimination of "step" frequency response with the simultaneous reduction in governor dead-band settings.

Improvements in the full AGC control loop of the generating resource, which accounts for the expected primary frequency response, have improved the delivery of quality primary frequency response while minimizing secondary control actions of generators. Some of these actions can provide quick improvement in delivery of primary frequency response.

Once primary frequency response sources are known the BA could calculate available reserves that are frequency responsive. Planning for these reserves during normal and emergency operations could be developed and added to the normal planning process.

#### Using FRS Form 1 Data

The information collected for this standard can be supplemented by a few data points to provide the Balancing Authority useful tools and information. The BA could do a regression analysis of its frequency response against the following values:

- Load (value A).
- Interchange (Value A).
- Total generation.
- Spinning reserve.

While the last two values above are not part of Form 1, they should be readily available. Small BAs might even include headroom on its larger generators as part of the regression.

The regression would provide a formula the BA could program in its EMS to present the operator a real time estimate of the BA's Frequency Response.

Statistical outliers in the regression would point to cases meriting further inspection to find causes of low Frequency Response or opportunities for improvement.

#### Tools

Single generating resource performance evaluation tools for steam turbine, combustion turbine (simple cycle or combined cycle) and for intermittent resources are available at the following link. [http://texasre.org/standards\\_rules/standardsdev/rsc/sar003/Pages/Default.aspx](http://texasre.org/standards_rules/standardsdev/rsc/sar003/Pages/Default.aspx).

These tools and the regional standard associated with them are in their final stages of development in the Texas region.

These tools will be posted on the [NERC website](#).

## Field Trial

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This section is a summary of the Field Trial activities that have been or will be conducted by the ERO, the Resources Subcommittee and the FRS Drafting Team.

1. The NERC BA recommendation (alert) and observations.v
2. The NERC governor recommendation (alert) and observations.v
3. The 2011 bias calculation v
  1. Evaluate measurement methodologyv
  2. Serve as initial training for BAsv
  3. Evaluate median, mean, regression and possibly other measuresv
  4. Evaluate sample size (to address the directive of frequency of surveys) v
  5. Evaluate impact of inclusion/exclusion of internal contingencies v
  6. Improve FRS Form 1v
4. Create supporting process for FRS Form 1 v
  1. For Interconnection benchmarking (proving adequacy of frequency response)
  2. Evaluating trend
  3. Test process for developing candidate list for FRS Form 1
5. 2012 bias calculation v
  1. Further refinement of items in 2011 bias calculation
  2. Test the FRO allocation methodology
  3. Test approach for handling variable bias
  4. Evaluate 12 month vs. 24 month rolling average approach to performance
6. Evaluate reduction in bias setting floor below 1% (initially 0.8% in 2013) to evaluate impact on frequency and calculated CPS and BAAL performance.
7. Evaluate effectiveness of administrative process to support the standard.
8. Evaluate a risk-based approach for basing the Interconnection Frequency Response Obligation on an historic probability density of frequency error, and for allocating the obligation on the basis of the Balancing Authority's average annual ACE share of frequency error.

## References

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NERC *Frequency Response Characteristic Survey Training Document* (Found in the NERC [Operating Manual](#))

[NERC Resources Subcommittee Position Paper on Frequency Response](#)

NERC TIS Report [Interconnection Criteria for Frequency Response Requirements \(for the Determination Interconnection Frequency Response Obligations \(IFRO\)\)](#)

DRAFT



## Appendix 1 - Data Quality Concerns Related To The Use Of The Actual Net Interchange Value

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Actual net interchange for a typical Balancing Authority (BA) is the summation of its tie lines to other BAs. In some cases, there are pseudo-ties in it which reflect the effective removal or addition of load and/or generation from another BA, or it could include supplemental regulation as well. But in the typical scenario, actual net interchange values that are extracted from EMS data archiving can be influenced by data latency times in the data acquisition process, and also any timestamp skewing in the archival process.

Of greater concern, however, are the inevitable variations of other operating phenomena occurring concurrently with a frequency event. The impacts of these phenomena are superimposed on actual net interchange values along with the frequency response that we wish to measure through the use of the actual net interchange value.

To explore this issue further, let's begin with the idealized condition:

- frequency is fairly stable at some value near or a little below 60 Hz
- ACE of the non-contingent BA of interest is 0 and has been 0 for an extended period, and AGC control signals have not been issued recently
- Actual net interchange is "on schedule", and there are no schedule changes in the immediate future
- BA load is flat
- All generators not providing AGC are at their targets
- Variable generation such as wind and solar are not varying
- Operators have not directed any manual movements of generation recently

And when the contingency occurs in this idealized state, the change in actual net interchange will be measuring only the decline in load due to lesser frequency and generator governor response, and, none of the contaminating influences. While the ACE may become negative due to the actual frequency response being less than that called for by the frequency bias setting within the BA's AGC system, this contaminating influence on measuring frequency response will not appear in the actual net interchange value if the measurement interval ends before the generation or AGC responds.

Now let's explore the sensitivity of the resultant frequency response sampling to the relaxation of these idealized circumstances.

1. The "60 Hz load" increases moderately due to time of day concurrent with the frequency event. If the frequency event happens before AGC or operator-directed manual load adjustments occur, then the actual net interchange will be reduced by the moderate increase in load and the frequency response will be underestimated. But if the frequency event happens while AGC response and/or manual adjustments occur, then the actual net interchange will be increased by the AGC response (and/or manual adjustments) and the frequency response will be overestimated.

2. The “60 Hz load” decreases moderately due to time of day concurrent with the frequency event. If the frequency event happens before AGC or operator-directed manual load adjustments occur, then the actual net interchange will be increased by the moderate reduction in load and the frequency response will be overestimated. But if the frequency event happens while AGC response and/or manual adjustments occur, then the actual net interchange will be decreased by the AGC response (and/or manual adjustments) and the frequency response will be underestimated.
3. In anticipation of increasing load during the next hour, the operator increases manual generation before the load actually appears. If the frequency event happens while the generation “leading” the load is increasing, then the actual net interchange will be increased by the increase in manual generation and the frequency response will be overestimated. But if the frequency event occurs when the result of AGC signals sent to offset the operator’s leading actions take effect, then the actual net interchange will be decreased and the frequency response is underestimated.
4. In anticipation of decreasing load during the next hour, the operator decreases manual generation before the load actually declines. If the frequency event happens while the generation “leading” the load downward is decreasing, then the actual net interchange will be decreased by the reduction in manual generation and the frequency response will be underestimated. But if the frequency event occurs when the result of AGC signals sent to offset the operator’s leading actions take effect, then the actual net interchange will be increased and the frequency response is overestimated.
5. A schedule change to export more energy is made at 5 minutes before the top of the hour. The BA’s “60 Hz load” is not changing. The schedule change is small enough that the operator is relying on upward movement of generators on AGC to provide the additional energy to be exported. The time at which the AGC generators actually begin to provide the additional energy is dependent on how much time passes before the AGC algorithm gets out of its deadbands, the individual generator control errors get large enough for sending out the control signal, and maybe 20 seconds to 3 minutes for the response to be effected. The key point here is that it is not clear when the effects of a schedule change, as manifested in a change in generation and then ultimately a change in actual net interchange, will occur.
6. With the expected penetration of wind in the near future, unanticipated changes in their output will tend to affect actual net interchange and add noise to the frequency response observation process.

To a greater or lesser extent, 1 through 4 above are happening continuously for the most part with most BAs in the Eastern and Western Interconnections. The frequency response is buried within the typical hour to hour operational cacophony superimposed on actual net interchange values. The choice of metrics will be important to artfully extract frequency response from the noise and other unrepresentative error.

**ATTACHMENT C**

**Frequency Response Standard Drafting Team**

## ATTACHMENT C

### Frequency Response Standard Drafting Team

#### Project 2007-12 — FRRSDT

Chairman - David F. Lemmons — Senior Manager, Market Operations - Xcel Energy, Inc.

Vice Chairman - Terry Bilke — Director, Standards and Compliance - Midwest ISO, Inc.

Don E Badley — System Operations Manager - Northwest Power Pool Corporation

Les Hajagos — Director/Senior Engineer - Kestrel Power Engineering Ltd

Howard F. Illian - Energy Mark, Inc.

Clyde Loutan — Senior Advisor — Planning and Infrastructure Development - California ISO

Carlos Martinez - Electric Power Group

James Murphy — Electrical Engineer - Bonneville Power Administration

Sydney Niemeyer — Control System Specialist - NRG Texas LP

Michael Potishnak — Principal Engineer - ISO New England, Inc.

Thomas E Washburn — Executive Director - Florida Municipal Power Pool

Sandip R. Sharma – Operations Engineer - ERCOT

NERC Staff Darrel Richardson — Standards Development Coordinator - North American Electric Reliability Corporation

**ATTACHMENT D**

**Table of Frequency Response Activities, Development of BAL-003-1**

**Table of Frequency Response Activities, Development of BAL-003-1**

<b>Date</b>	<b>Description</b>
<b>2010</b>	
March 16-17, 2010	Overview of Frequency Response Initiative presented by Robert Cummings, Director of System Analysis and Reliability Initiatives to the NERC Planning and Operating Committees. <sup>1</sup>
May 7, 2010	Standard Drafting Team Conference Call: Worked on standard development: reviewed and modified definitions, purpose statement, requirements and Attachment A.
May 13, 2010	Standard Drafting Team Conference Call: Worked on standard development: reviewed and modified definitions, requirements, measures and reviewed Attachments A and B.
May 13, 2010	FERC Order Granting Rehearing for Further Consideration and Scheduling Technical Conference. <i>Mandatory Reliability Standards for the Bulk Power System</i> , 131 FERC ¶ 61,136 (2010).
May 14, 2010	Standard Drafting Team Conference Call: Discussion of FERC Order on rehearing; Worked on standard development: reviewed and modified requirements and VSLs.
May 24-25, 2010	Standard Drafting Team Meeting: Worked on standard development: reviewed and modified requirements, discussed applicability, and reviewed Attachments A and B.
June 7, 2010	Standard Drafting Team Conference Call: Worked on standard development: reviewed and modified requirements and measures. Presentation regarding methods of calculating Frequency Response using normalized median values vs. normalized average values vs. regression.
September 16, 2010	Standard Drafting Team Conference Call: Worked on standard development: reviewed and modified background document.
September 23, 2010	FERC Technical Conference: RM06-16-11: Technical Issues Relating to Frequency Response Requirements for the Eastern, Western and Texas Interconnections.
November 23, 2010	NERC Resources Subcommittee Discussion Draft of Position Paper on Frequency Response Issued <sup>2</sup>
December 3, 2010	Standard Drafting Team Conference Call: Worked on standard development: reviewed and modified VSLs and criteria for selecting frequency events.
December 8, 2010	Standard Drafting Team Conference Call: Worked on standard development: reviewed and modified definition for Frequency Bias Setting, Attachment A and reviewed FRS Form 1 and FRS Form 1 instructions.

<sup>1</sup> Available here: <http://www.spp.org/publications/NERC%20Frequency%20Response%20Initiative%20Overview.pdf>.

<sup>2</sup> Available here: [http://www.nerc.com/docs/oc/rs/NERC%20RS%20Position%20Paper%20on%20Frequency%20Response%20\(Discussion%20Draft\).pdf](http://www.nerc.com/docs/oc/rs/NERC%20RS%20Position%20Paper%20on%20Frequency%20Response%20(Discussion%20Draft).pdf).

**Table of Frequency Response Activities, Development of BAL-003-1**

<b>Date</b>	<b>Description</b>
<b>2011</b>	
January 26, 2011	NERC Resources Subcommittee Technical Document on Balancing and Frequency Control Issued <sup>3</sup>
February 4, 2011 – March 7, 2011	30 Day Comment Period on BAL-003
March 8-9, 2011	NERC Resources Subcommittee Position Paper on Frequency Response Accepted by the NERC Operating Committee. <sup>4</sup>
March 15-17, 2011	Standard Drafting Team Meeting: Discussed proposed field trial; presentation regarding proposal for using a probabilistic method for determining a Balancing Authority’s Frequency Response Obligation
April 4-5, 2011	Standard Drafting Team Conference Call: Reviewed and addressed comments received and revised associated documents.
April 7, 2011	Standard Drafting Team Conference Call: Reviewed and addressed comments received and revised associated documents.
April 15, 2011	Standard Drafting Team Conference Call: Reviewed and addressed comments received and revised associated documents.
May 5, 2011	Standard Drafting Team Conference Call: Reviewed and addressed comments received and revised associated documents.
May 11, 2011	Standard Drafting Team Conference Call: Reviewed and addressed comments received and revised associated documents.
May 18-19, 2011	Standard Drafting Team Meeting: Reviewed field trial; reviewed FERC directives; reviewed associated documents
June 2-3, 2011	Standard Drafting Team Meeting: Reviewed field trial. The Drafting Team moved the trigger for candidate events from 750 MW to 1000 MW for the Eastern Interconnection.
July 8, 2011	Standard Drafting Team Conference Call: Reviewed and finalized draft standard. Drafting Team modified Table 1 to reflect “Under Frequency” and “Over Frequency” values. Drafting Team made minor modifications to the criteria for selecting events.
July 11, 2011	Standard Drafting Team Conference Call: Reviewed and finalized Attachment A; reviewed and finalized background document.
July 18, 2011	NERC conducts Industry Webinar <sup>5</sup>
July 26, 2011	Quality review of Frequency Response standard draft
August 4, 2011	Standard Drafting Team Conference Call: Discussion of quality review comments and revised documents based on the comments received
August 5, 2011	Standard Drafting Team Conference Call: Discussion of quality review

<sup>3</sup> Available here:  
<http://www.nerc.com/docs/oc/rs/NERC%20Balancing%20and%20Frequency%20Control%20040520111.pdf>.

<sup>4</sup> Available here:  
[http://www.nerc.com/docs/oc/rs/NERC%20RS%20Position%20Paper%20on%20Frequency%20Response%20Final%20\(May%2027%202011\).pdf](http://www.nerc.com/docs/oc/rs/NERC%20RS%20Position%20Paper%20on%20Frequency%20Response%20Final%20(May%2027%202011).pdf).

<sup>5</sup> Materials available here:  
[http://www.nerc.com/files/NERC Frequency Response Standard Webinar 2011 07 18.pdf](http://www.nerc.com/files/NERC%20Frequency%20Response%20Standard%20Webinar%202011%2007%2018.pdf).

**Table of Frequency Response Activities, Development of BAL-003-1**

<b>Date</b>	<b>Description</b>
	comments and revised documents based on the comments received
September 1-2, 2011	Standard Drafting Team Meeting: Reviewed Transmission Issues Subcommittee Report on Interconnection Criteria for Frequency Response Requirements; reviewed data submitted by Balancing Authorities
September 26, 2011	Standard Drafting Team Conference Call: Discussion of field trial; Drafting Team reconfirmed that the 20 to 52 second interval was the proper one to use for the B point.
October 25, 2011 – December 9, 2011	45 Day Comment Period on BAL-003
November 14, 2011	NERC conducts Industry Webinar <sup>6</sup>
December 14-15, 2011	Standard Drafting Team Meeting: Reviewed and addressed comments from second posting and initial ballot and identified the major issues raised by the industry.
<b>2012</b>	
January 9, 2012	Standard Drafting Team Conference Call: Reviewed Drafting Team responses to issues including RSG vs. FRSG, the median measure, fixed bias v. variable bias and the maximum frequency response responsibility. Reviewed Drafting Team response to comments.
January 13, 2012	Standard Drafting Team Conference Call: Reviewed Drafting Team response to comments.
January 18-20, 2012	Standard Drafting Team Meeting: Reviewed paper on Discussion of the Preliminary Choice of the Median as the Sampling Aggregate Technique. Discussed the use of Variable Bias. Worked on standard development: reviewed and modified requirements, definition of Frequency Response Sharing Group, background document, and Attachments A and B.
February 6, 2012	Standard Drafting Team Conference Call: Discussed minimum variable bias issue. Reviewed comments from quality review.
February 8, 2012	Standard Drafting Team Conference Call: Reviewed proposed justification for removing the requirement for a single Balancing Authority to have a minimum FBS. Reviewed comments from quality review. Worked on standard development: reviewed and modified background document and Attachments A and B.
February 10, 2012	Standard Drafting Team Conference Call: Worked on standard development: reviewed and modified background document and Attachments A and B. Reviewed response to comments.

<sup>6</sup> Materials available here: <http://www.nerc.com/files/Webinar%20Slides%20-%20Project%202007-12%20Frequency%20Response%20-%20November%2014%202011.pdf>.



**Attachment E**

**Frequency Response Standard Drafting Team Meeting Minutes, 2010**

## Minutes Frequency Response SDT— Project 2007-12

May 7, 2010 2:00 P.M. – 5:00 P.M. EPT

### Administrative

1. Introductions/Attendees
  - A. Bill Herbsleb opened the meeting with introductions.
  - B. The following people attended the meeting:  
Team members

Bill Herbsleb	Howard Illian
Sydney Neimeyer	Dave Lemmons
Carlos Martinez	Mike Potishnak
Don Badley	Darrel Richardson

  
Observers

Doug Hils	Leroy Patterson
Robert Blohm	Leslie Williams
2. Review NERC Antitrust Compliance Guidelines
  - A. Darrel Richardson read the NERC Antitrust Guidelines
3. Approve and Set Timing for this Agenda.
  - A. The agenda was approved with no additions.

## **Standard Development**

1. General (see attached draft standard)
  - a) The Definitions were reviewed and modified as follows:
    - i) FRM modified to provide increased understanding of what is being requested.
    - ii) FRR was changed to FRO (Frequency Response Obligation) and a definition was developed.
  - b) Review, discuss and modify draft standard
  - c) Purpose Statement reviewed and a minor modification was made to provide further clarity.
  - d) Applicability section reviewed with no modifications suggested.
  - e) Requirements reviewed
    - i) Requirements R1 was reviewed and a minor modification was made to clarify
    - ii) Requirement R2 was extensively modified using FRM and FRO.
    - iii) Requirement R3 was extensively modified adding timing of when Bias is to be established and an effective date added.
2. Review Attachment A (see attached)
  - a) The Team briefly reviewed the attachment. The Team decided that the attachment should be broken in to two separate attachments – Attachment A detailing calculation of SEFRD and FRM and Attachment B detailing calculation of FRO.
3. Finalize Comment Form
  - a) Deferred

## **Future Meetings/Conference Call(s)**

1. Set date for next meeting
  - a) The Team agreed to a conference call date(s):
    - i) Friday May 11, 2010 2:00 P.M. – 5:00 P.M. EPT

## Minutes Frequency Response SDT— Project 2007-12

May 11, 2010 | 2:00 P.M. – 5:00 P.M. EPT

### Administrative

1. Introductions/Attendees
  - A. Bill Herbsleb opened the meeting with introductions.
  - B. The following people attended the meeting:
    - Team members

Bill Herbsleb	Howard Illian
Carlos Martinez	Terry Bilke
Don Badley	Tom Washburn
Darrel Richardson	

    - Observers

Doug Hils	Leroy Patterson
Robert Blohm	Rick Vara
Leslie Williams	
2. Review NERC Antitrust Compliance Guidelines
  - A. Darrel Richardson read the NERC Antitrust Guidelines
3. Approve and Set Timing for this Agenda.
  - A. The agenda was approved with no additions.

## **Standard Development**

1. General (see attached draft standard)
  - a) The Definitions were reviewed and modified to provide for further clarity.
  - b) Review, discuss and modify draft standard
  - c) Purpose Statement reviewed with no modifications suggested.
  - d) Applicability section reviewed with no modifications suggested.
  - e) Requirements reviewed
    - i) Requirements R1 and R2 were reviewed and modified.
      - (1) SEFD and FRM were added to R1
      - (2) Minor modifications were made to R2 to provide further clarity.
    - ii) Minor modifications were made to Requirements R3.1 and R3.2 to provide further clarity.
  - f) Measure
    - i) The Measures were completely re-written by Bill Herbsleb, Leroy Patterson and Darrel Richardson to provide a starting point for discussion during the next meeting.
2. Review Attachment A (see attached)
  - a) The Team briefly reviewed the attachment but decided to hold off on any modifications.
3. Review Attachment B (see attached)
  - a) The Team briefly reviewed the attachment but decided to hold off on any modifications.
4. Finalize Comment Form
  - a) Deferred

## **Future Meetings/Conference Call(s)**

1. Set date for next meeting
  - a) The Team agreed to a conference call date(s):
    - i) Friday May 13, 2010 2:00 P.M. – 5:00 P.M. EPT

## Minutes Frequency Response SDT— Project 2007-12

May 13, 2010 | 2:00 P.M. – 5:00 P.M. EPT

### Administrative

1. Introductions/Attendees
  - A. Bill Herbsleb opened the meeting with introductions.
  - B. The following people attended the meeting:
    - Team members

Bill Herbsleb	Howard Illian
Sydney Neimeyer	Dave Lemmons
Carlos Martinez	Terry Bilke
Don Badley	Clyde Loutan
Darrel Richardson	

    - Observers

Doug Hils	Leroy Patterson
Robert Blohm	Scott Sells
Leslie Williams	
2. Review NERC Antitrust Compliance Guidelines
  - A. Darrel Richardson read the NERC Antitrust Guidelines
3. Approve and Set Timing for this Agenda.
  - A. The agenda was approved with no additions.

## Standard Development

1. General
  - a) The Definitions were reviewed and modified to provide for further clarity.
2. Review, discuss and modify draft standard (see attached draft standard)
  - a) Purpose Statement reviewed with no modifications suggested.
  - b) Applicability section reviewed with no modifications suggested.
  - c) Requirements reviewed
    - i) Requirements R1 and R2 were reviewed and modified.  
(1) FRM was removed from R1 and moved into R2.
    - ii) Requirements R3 and R4 were modified to provide further clarity.
  - d) Measure
    - i) Measures M1 and M2 were modified to coincide with the modifications made to R1 and R2..
    - ii) Measures M3 and M4 were extensively modified to provide much needed clarity.
  - e) VSLs
    - i) Howard Illian agreed to provide the Team with a first cut on the VSLs prior to the next meeting.
3. Review Attachment A (see attached)
  - a) The Team briefly reviewed the attachment but decided to hold off on any modifications.
4. Review Attachment B (see attached)
  - a) The Team briefly reviewed the attachment but decided to hold off on any modifications.
5. Finalize Comment Form
  - a) Deferred

## Future Meetings/Conference Call(s)

1. Set date for next meeting
  - a) The Team agreed to a conference call date(s):
    - i) Friday May 14, 2010 2:00 P.M. – 5:00 P.M. EPT

## Minutes Frequency Response SDT— Project 2007-12

May 14, 2010 | 2:00 P.M. – 5:00 P.M. EPT

### Administrative

1. Introductions/Attendees

A. Bill Herbsleb opened the meeting with introductions.

B. The following people attended the meeting:

Team members

Bill Herbsleb

Howard Illian

Sydney Neimeyer

Dave Lemmons

Carlos Martinez

Terry Bilke

Don Badley

Tom Washburn (conf call)

Darrel Richardson

Observers

Rick Vara

Leroy Patterson

Robert Blohm

Scott Sells

Doug Hils

2. Review NERC Antitrust Compliance Guidelines

A. Darrel Richardson read the NERC Antitrust Guidelines

3. Approve and Set Timing for this Agenda.

A. The agenda was approved with no additions.



## Standard Development

1. General
  - a) Darrel Richardson advised the Team that FERC had issued an Order removing (for the time being) the six month deadline for developing a new BAL-003 standard. Darrel further stated that it would be necessary for the Team to continue with its efforts to develop a new Standard in the near future.
  - b) Scott Sells (FERC) was asked if he knew the date FERC was planning on holding the Technical Conference on BAL-003. He stated that to his knowledge, no dates had been selected.
  - c) Darrel Richardson advised the Team that FERC had
2. Review, discuss and modify draft standard (see attached draft standard)
  - a) Purpose Statement reviewed with no modifications suggested.
  - b) Applicability section reviewed with no modifications suggested.
  - c) Requirements reviewed
    - i) The Team discussed suggested wording from Terry Bilke that would shorten the proposed requirements. The Team was generally in disagreement with his proposed wording.
    - ii) The Team reviewed the Requirements and made no modifications.
  - d) Measure
    - i) The Team reviewed the Measures and made no modifications.
    - ii) Dave Lemmons expressed a concern that he was concerned that the way M3 was worded an entity could receive multiple violations. The Team generally did not agree. However, Robert Blohm is going to provide alternate wording for the Team to consider.
  - e) VSLs
    - i) The Team reviewed the VSLs that Howard Illian had provided. The Team made minor modifications to the VSLs.
3. Review Attachment A (see attached)
  - a) The Team briefly reviewed the attachment but decided to hold off on any modifications until the next meeting.
4. Review Attachment B (see attached)
  - a) The Team briefly reviewed the attachment but decided to hold off on any modifications until the next meeting.
5. Finalize Comment Form
  - a) Deferred

## **Future Meetings/Conference Call(s)**

1. Set date for next meeting
  - a) The Team agreed to the a meeting to be held at the MISO office in Carmel Indiana on the following dates:
    - i) Monday May 24, 2010 10:00 A.M. – 5:00 P.M. EPT
    - ii) Tuesday May 25, 2010 8:00 A.M. – 3:00 P.M. EPT

## Minutes Frequency Response SDT— Project 2007-12

May 24, 2010 | 10:00 A.M. – 5:00 P.M. EPT

May 25, 2010 | 8:00 A.M. - 3:00 P.M. EPT

Midwest ISO Office  
720 City Center Drive  
Carmel, IN

### Administrative

#### 1. Introductions/Attendees

A. Bill Herbsleb opened the meeting with introductions.

B. The following people attended the meeting:

#### Team members

Bill Herbsleb

Mike Potishniak

Sydney Neimeyer

Dave Lemmons

Clyde Loutan

Terry Bilke

Don Badley

Tom Washburn (conf call)

Howard Illian (conf call)

Carlos Martinez (conf call)

Darrel Richardson

#### Observers

Gerry Beckerle (conf call)

Leroy Patterson (conf call)

Robert Blohm (conf call)

Scott Sells (conf call)

Doug Hils

Bob Cummings

2. Review NERC Antitrust Compliance Guidelines
  - A. Darrel Richardson read the NERC Antitrust Guidelines
3. Approve and Set Timing for this Agenda.
  - A. The agenda was approved with one addition – Bob Cummings Generator Survey.

## **Standard Development**

1. Review, discuss and modify draft standard (see attached draft standard)
  - a) Purpose Statement reviewed with no modifications suggested.
  - b) Applicability section reviewed
    - i) Don Badley wanted to add Generator Operators to Applicability. Team did not agree although did feel a standard needed to be developed for Generator Operators.
  - c) Requirements reviewed
    - i) The Team discussed Terry Bilke’s suggested wording for all requirements. The Team was generally in disagreement with his proposed wording.
    - ii) The Team modified Requirements R2 and R3.
      - (1) R2 modified – reference to Appendix B was removed based on Bob Cummings advice that it should actually be referenced in the NERC Rules of Procedure. Bob will check with NERC legal. Other modifications made for clarity.
      - (2) R3 modified – mainly to provide for further clarity. Bill Herbsleb and Mike Potshiniak will check with those entities using “variable bias” to see if there are any commonalities. Howard Illian will provide language for qualifiers on use of variable bias.
  - d) Compliance
    - i) Darrel Richardson will have someone from NERC Compliance look over the compliance (VRFs, VSLs, Horizons and Measures) to gain their input.
2. Review Attachment A (see attached)
  - a) The Team briefly reviewed the attachment but decided to hold off on any modifications until the next meeting.
3. Review Attachment B (see attached)
  - a) The Team briefly reviewed the attachment but decided to hold off on any modifications until the next meeting.
4. Finalize Implementation Period and Plan
  - a) Deferred
5. Finalize Comment Form
  - a) Deferred

6. **Bob Cummings Presentation** (see attached Survey)
  - a) Bob Cummings presented the Team with a preliminary version of the Generator Survey NERC will be sending out to all Generator Owners/Operators. The Team offered several suggested modifications to Bob's survey which he accepted.
7. **The Team looked at FERC Order 693 to ensure the directives were being covered.**

#### **Future Meetings/Conference Call(s)**

1. Set date for next meeting
  - a) The Team agreed to the following conference calls:
    - i) Monday June 7, 2010 2:00 P.M. – 5:00 P.M. EPT
    - ii) Friday June 18, 2010 2:00 P.M. – 5:00 P.M. EPT (Tentative)

## Minutes Frequency Response SDT— Project 2007-12

June 7, 2010 2:00 P.M. – 5:00 P.M. EPT

### Administrative

1. Introductions/Attendees
  - A. Bill Herbsleb opened the meeting with introductions.
  - B. The following people attended the meeting:
    - Team members

Bill Herbsleb	Mike Potishnak
Carlos Martinez	Terry Bilke
Don Badley	Tom Washburn
Howard Illian	Carlos Martinez
Darrel Richardson	

    - Observers

Gerry Beckerle	Leroy Patterson
Rick Vara	Leslie Williams
2. Review NERC Antitrust Compliance Guidelines
  - A. Darrel Richardson read the NERC Antitrust Guidelines
3. Approve and Set Timing for this Agenda.
  - A. The agenda was approved with no additions.

## Standard Development

1. Review, discuss and modify draft standard (see attached draft standard)
  - a) Definitions reviewed with no modifications suggested.
  - b) Purpose Statement reviewed with no modifications suggested.
  - c) Applicability section reviewed with no modifications suggested.
  - d) Requirements reviewed
    - i) The Team discussed whether Requirements R2 and R3 should be broken into multiple requirements. The Team decided that they should since they were calling for multiple items.
      - (1) Darrel Richardson volunteered to break these Requirements apart and send out to the Team for consideration.
    - ii) The Team modified Requirements R2 and R3.
  - e) Measures
    - i) The Team began review Robert Blohm's suggested wording for the Measures. The Team accepted his proposed wording for M1 and M22. The Team then decided to table any further discussion on the measures until Requirements R2 and R3 are broken apart.
    - ii) Darrel Richardson volunteered to break the existing measures apart to coincide with the modifications to Requirements R2 and R3.
2. Review Attachment A
  - a) The Team deferred discussion until the next meeting.
3. Review Attachment B
  - a) The Team deferred discussion until the next meeting.
4. Mike Potishnak presentation
  - a) Mike Potishnak reviewed a spreadsheet he developed comparing methods of calculating Frequency Response using Normalized Median Values vs Normalized Average Values vs Regression.
  - b) Mike believes that the Normalized Median provides the best method. The Team is reviewing his spreadsheet to develop their individual opinions.
  - c) Mike also requested that if anyone was interested in providing additional data he would be very interested in receiving the data.
  - d) Mike requested that this spreadsheet only be distributed among the members of the DT.

## Action Items

1. Darrel Richardson will modify Requirements R2 and R3 along with Measures M2 and M3 and sent to the Team for review.
2. Bill Herbsleb and Mike Potishnak will check with those entities using "variable bias" to see if there are any commonalities.
3. Howard Illian will provide language for qualifiers on use of variable bias.
4. Bill Herbsleb will develop the Principles of What Establishes FRM.

**Future Meetings/Conference Call(s)**

1. Set date for next meeting
  - a) The Team agreed to the following conference calls:
    - i) Friday June 18, 2010 2:00 P.M. – 5:00 P.M. EPT (Cancelled)
    - ii) Friday June 25, 2010 2:00 P.M. – 5:00 P.M. EPT
    - iii) Friday July 16, 2010 2:00 P.M. – 5:00 P.M. EPT (Tentative)



## Minutes Frequency Response SDT — Project 2007-12

September 16, 2010 | 10:00 A.M. - 1:00 P.M. EPT

### Administrative

1. Introductions/Attendees

- A. Bill Herbsleb opened the meeting with introductions.
- B. The following people attended the meeting:

Team members

Bill Herbsleb	Mike Potishnak
Sydney Neimeyer	Terry Bilke
Don Badley	Howard Illian
Carlos Martinez	Tom Vandervort

Observers

Gerry Beckerle	
Robert Blohm	Scott Sells
Doug Hils	Edwin Thompson
Rick Vara	Ken McKentyre

2. Review NERC Antitrust Compliance Guidelines

- A. Darrel Richardson read the NERC Antitrust Guidelines

3. Goal of meeting

- A. Darrel Richardson and Bill Herbsleb explained to the SDT that the goal of the meeting was to review the Background Document and to have a product to post for an informal comment period by the end of the meeting.
- 4. Approve and Set Timing for this Agenda.
  - A. The agenda was approved.

### **Standard Development**

- 1. Review, discuss and modify Background Document (see attached Background Document)
  - a) Introduction was reviewed and modified.
  - b) Requirement 1 and Measure 1 background information were reviewed and modified.
  - c) Requirement 2 and Measure 2 background information were reviewed and modified.
  - d) Requirement 3 and Measure 3 background information were reviewed and modifications to the Measure 3 background information were made.
  - e) Requirement 4 and Measure 4 background information were reviewed and modifications to the Measure 4 background information were made.
- 2. Next Step(s)
  - a) Darrel Richardson will make changes to the Background Document and send the following documents to the SDT for their review:
    - i) Draft Standard ( excluding the VRFs and VSLs).
    - ii) Draft Implementation Plan.
    - iii) Draft Background Document.
    - iv) Draft Criteria for Selecting Events.
    - v) FRS Form 1.
    - vi) FRS Form 1 Instructions.
    - vii) Draft Comment Form.
  - b) Darrel Richardson will review comments received from the SDT, modify the aforementioned documents and send to NERC Staff for review and posting for a 30 day informal comment period.

### **Future Meetings/Conference Call(s)**

- 1. Set date for next meeting
  - i) The Team agreed to a conference call on Friday October 8, 2010 from 2:00 P.M. to 5:00 P.M. EPT to discuss the methodology document covering FRO.

## Agenda & Meeting Minutes Frequency Response Standard Drafting Team

Conference Call  
Friday December 3, 2010 10:30 A.M. – 1:30 P.M. EPT  
Web Conference  
Conference Server 1.866.740.1260  
Participant Code 6131848

### Administrative

1. Introductions/Attendees

A. Team Members

Bill Herbsleb

Sydney Niemeyer

Don Badley

Howard Illian

Darrel Richardson

B. Non-members

LeRoy Patterson

Robert Blohm

Scott Sells

Ed Thompson

Troy Blalock

Matt Cinadr

Gerry Beckerle

Doug Hils

2. Review NERC Antitrust Compliance Guidelines

A. Darrel Richardson reviewed the guidelines

3. Review NERC Reminder

A. Darrel Richardson reviewed the reminder

4. Approve and Set Timing for this Agenda.

### **Standard Development (see attached documents)**

1. Review draft standard
  - a) The standard was reviewed with no revisions the requirements
  - b) The VSLs were modified
2. Review Attachment A – Background Document
  - a) The document was reviewed with slight modifications
3. Review Criteria for Selecting Frequency Events
  - a) The criteria was reviewed and decided to include it into Attachment A
4. Review Implementation Plan
  - a) Deferred to next meeting
5. Review FRS Form 1 and FRS Form 1 Instructions
  - a) Deferred to next meeting
6. Review Comment Form
  - a) Deferred to next meeting
7. Next steps/Action Items
  - a) The SDT will review all documents prior to next meeting
  - b) The SDT will review all documents prior to next meeting

### **Future Meetings/Conference Call(s)**

1. Conference Call
  - a) Wednesday December 8, 2010 1:00 P.M. – 5:00 P.M. EPT

## Agenda

### Frequency Response Standard Drafting Team

Conference Call  
Wednesday December 8, 2010 1:00 P.M. – 5:00 P.M. EPT  
Web Conference  
Conference Server 1.866.740.1260  
Participant Code 6131848

#### Administrative

1. Introductions/Attendees
  - A. Team Members

Bill Herbsleb	Howard Illian
Carlos Martinez	Don Badley
Sydney Niemeyer	Darrel Richardson
  - B. Non-members

Robert Blohm	Scott Sells
Gerry Beckerle	LeRoy Patterson
2. Review NERC Antitrust Compliance Guidelines
  - A. Darrel Richardson reviewed the guidelines
3. Review NERC Reminder
  - A. Darrel Richardson reviewed the reminder
4. Approve and Set Timing for this Agenda.

#### Standard Development

1. Review draft standard

- a) The Standard was reviewed – the SDT decided to revise the definition for Frequency Bias Setting
2. Review Attachment A – Background Document
  - a) The document was reviewed and minor changes were made
3. Review Implementation Plan
  - a) The document was reviewed and no changes were made
4. Review FRS Form 1 and FRS Form 1 Instructions
  - a) The document was reviewed and no changes were made
5. Review Comment Form
  - a) The document was reviewed and minor changes were made
6. Next steps/Action Items
  - a) Darrel Richardson will make all modifications to all documents and send to the Team for final review by Friday December 10, 2010 12:00 P.M. EPT

**Future Meetings/Conference Call(s)**

1. This will be decided once the proposed documents have been reviewed by NERC staff.

## **Attachment F**

### **Frequency Response Standard Drafting Team Meeting Minutes, 2011**

## Meeting Notes Project 2007-12 Frequency Response

March 15-17, 2011 | 8:00 a.m. – 5:00 p.m. ET  
PJM Valley Forge Campus  
Norristown, PA

### Administrative

#### 1. Introductions/Attendees

- Meeting Attendees

Sydney Niemeyer, NRG Texas, LP

Clyde Loutan, California, ISO

Don Badley, NPPC

Troy Blalock, SCE&G

Mike Potishnak, ISO new England, Inc.

LeRoy Patterson, Patterson Consulting

David Lemmons, Xcel Energy, Inc.

Carlos Martinez, Advanced Systems Researchers

Phil Tatro, NERC

Bill Herbsleb, PJM Interconnection, LLC

Tom Hauske, PJM Interconnection, LLC

Brad Gordon, PJM Interconnection, LLC

Darrel Richardson, NERC

Scott Sells, FERC, via teleconference

Howard Illian, Energy Mark, Inc., via teleconference

Gerry Beckerle, Ameren Corp., via teleconference

Matt Cinadr, Public Service Commission of New York

Robert Blohm, Unavailable



2. Review NERC Antitrust Compliance Guidelines
  - Darrel Richardson reviewed the NERC Antitrust Guidelines.
3. Review Meeting Reminder.
  - Darrel Richardson reviewed the NERC meeting reminder.

## **Standard Development**

1. Discuss Proposed Field Trial (60 minutes)
  - The field trial was discussed at length. It was determined that instead of asking a Balancing Authority to modify its Frequency Bias Setting the SDT would do manual calculations to simulate the results.
2. Howard Illian Alternative (3 Hours)
  - Howard Illian reviewed his proposal for using a probabilistic method for determining a Balancing Authority's Frequency Response Obligation (see attached presentation).
3. Address Comments Received From Formal Comment Period
  - The SDT began addressing the comments received from the formal posting (see attached comment document).
4. Review Draft Standard for Modifications
  - Deferred to next meeting.
5. Review Implementation Plan
  - Deferred to next meeting.
6. Discuss Dates for Possible Webinar (60 minutes)
  - Deferred to next meeting.
7. Review Associated Documents
  - Deferred to next meeting.

8. Next steps

- Action Items
  - The SDT was assigned a question from the comment report to provide an initial draft response for the team to consider at the next meeting (see attached assignment document). The Team is to have their responses to Darrel Richardson by 8:00 A.M. ET on Monday March 28, 2011.
  - Darrel Richardson will provide modified responses for the questions covered at the meeting and will collate the draft responses from the team into a single document. He will distribute the new document to the team by COB Wednesday March 30, 2011.

**Future Meetings/Conference Call(s)**

1. Set date for next meeting
  - Meeting at the Philadelphia Airport Marriott
    - April 4, 2011 8:00 A.M. – 5:00 P.M. ET
    - April 5, 2011 8:00 A.M. – 3:00 P.M. ET

## Meeting Notes Project 2007-12 Frequency Response

April 4, 2011 | 8:00 a.m.–5:00 p.m. ET

April 5, 2011 | 8:00 a.m.–3:00 p.m. ET

Philadelphia Airport Marriott  
Philadelphia, PA

### Administrative

#### 1. Introductions and attendance

Attendees: Don Badly, NWPP; Terry Bilke, MISO; Troy Blalock, SCANA; Brad Gordon, PJM; Tom Hauske, PJM; Bill Herbsleb, PJM; Carlos Martinez, AS Researchers; Sydney Niemeyer, NRG; Mike Potishnak, ISO New England; Scott Sells, FERC; Ron Varraneault, NERC Consultant; Tom Washburn, FMPP; Andy Rodriguez, NERC (April 5<sup>th</sup> only); Darrel Richardson, NERC; Phil Tatro, NERC.

Conference Call: Robert Blohm, Consultant; Matt Cinnadr, DPS New York; Howard Illian, EnergyMark; LeRoy Patterson, Patterson Consulting; Tom Siegrist, Enervision (April 5<sup>th</sup> only); Bob Cummings, NERC (April 5<sup>th</sup> only).

#### 2. Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Standard Development

#### 1. Address Comments Received from Formal Comment Period

- a. Question #6 was reviewed and responses were provided
- b. Question #9 was deferred
- c. Question #11 was reviewed and responses were provided
- d. Question #14 was reviewed and responses were provided
- e. Question #16 was reviewed and responses were provided
- f. Question #17 was reviewed and responses were provided

2. **Review Draft Standard for Modifications — Deferred to a Later Meeting**
3. **Review Implementation Plan for Modifications — Deferred to a Later Meeting**
4. **Discuss Possible Dates for Webinar (60 Minutes) — Deferred to a Later Meeting**
5. **Review Associated Documents — Deferred to a Later Meeting**
6. **Bob Cummings Presentation**
  - a. Bob Cummings reported that additional funds were being made available for the Frequency Response Initiative and the Frequency Response Standard analysis
  - b. Bob Cummings also reported that he had contracted with LB&L and the University of Tennessee
7. **Mike Potishnak Presentation**
  - a. Mike Potishnak presented his findings on the use of mean vs. median vs. regression. He believes that the median provides the best results.

#### **Future meeting(s)/conference call(s)**

1. **Conference call scheduled for April 7, 2011**

## Meeting Notes Project 2007-12 Frequency Response

April 7, 2011 | 10:30 a.m.–12:30 p.m. ET

Conference Call

### Administrative

#### 1. Introductions and attendance

Attendees: Gerry Beckerle, Ameren; Terry Bilke, MISO; Robert Blohm, Consultant; Matt Cinadr, DPS New York; Brad Gordon, PJM; Bill Herbsleb, PJM; Howard Illian, EnergyMark; Sydney Niemeyer, NRG; LeRoy Patterson, Patterson Consulting; Mike Potishnak, ISO New England; Scott Sells, FERC; Ron Varraneault, NERC Consultant; Tom Washburn, FMPP; Darrel Richardson, NERC; Phil Tatro, NERC.

#### 2. Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Agenda

#### 1. Address Comments Received from Formal Comment Period

- a. Question #7 — reviewed and updated
- b. Question #8 — reviewed and updated
- c. Question #10 — deferred until next meeting
- d. Question #12 — deferred until next meeting
- e. Question #13 — deferred until next meeting
- f. Question #15 — deferred until next meeting

#### 2. Next Steps

- a. Continue reviewing responses to comments received

### Future meeting(s)/conference call(s)

1. Conference call scheduled for April 15, 2011
2. Meeting scheduled for May 18-19, 2011 at the MISO office in Caramel, IN

## Agenda & Meeting Notes Frequency Response Standard Drafting Team

### Meeting/Conference Call

Conference Call

1.866.740.1260

6131848 Participant code

Friday April 15, 2011 10:30 A.M. - 12:30 P.M. EDT

### Administrative

1. Introductions/Attendees

Tom Siegrist – EnerVision

Brad Gordon – PJM

Don Badley – NWPP

Gerry Beckerle – Ameren

LeRoy Patterson – Patterson Consulting

Tom Washburn – FMPP

Scott Sells – FERC

Howard Illian – EnergyMark

Bill Herbsleb – PJM

Phil Tatro – NERC

Robert Blphm – Consultant

Sydney Niemeyer – NRG

Bob Cummings – NERC

Carlos Martinez – AS Researchers

Mike Potishnak – ISO New England

Terry Bilke – MISO

Darrel Richardson - NERC

2. Review NERC Antitrust Compliance Guidelines

A. Darrel Richardson reviewed the NERC Antitrust Guidelines

3. Review Meeting Reminder.

A. Darrel Richardson reviewed the NERC meeting reminder

### Standard Development

1. Address Comments Received
  - a) Question #10
    - i) Question # 10 was reviewed and finalized
  - b) Question #12
    - i) Deferred to next meeting
  - c) Question #13
    - i) Deferred to next meeting
  - d) Question #15\
    - i) Deferred to next meeting
2. Next steps

### **Future Meetings/Conference Call(s)**

1. Next team meeting –

May 3, 2011 10:00 A.M. – 12:00 P.M. EDT  
FERC Office Washington D.C.
2. Conference Call –

Thursday May 5, 2011 2:00 P.M. – 5:00 P.M. EDT

## Agenda & Meeting Notes Frequency Response Standard Drafting Team

### Meeting/Conference Call

Conference Call

1.866.740.1260

6131848 Participant code

Thursday May 5, 2011 2:00 P.M. - 5:00 P.M. EDT

### Administrative

1. Introductions/Attendees

Brad Gordon – PJM

Gerry Beckerle – Ameren

Mike Potishnak – ISO New England

Terry Bilke – MISO

Tom Washburn – FMPP

Scott Sells – FERC

Matt Cinadr – DPS New York

Howard Illian – EnergyMark

Bill Herbsleb – PJM

Darrel Richardson – NERC

Andy Rodriguez - NERC

2. Review NERC Antitrust Compliance Guidelines

A. Darrel Richardson reviewed the NERC Antitrust Guidelines

3. Review Meeting Reminder.

A. Darrel Richardson reviewed the NERC meeting reminder

### Standard Development

1. Address Comments Received

a) Question #12

i) Question #12 was reviewed



- ii) Terry Bilke will provide a response to Northwest Energy comment
  - b) Question #13
    - i) Question #13 was reviewed
    - ii) Terry Bilke will provide a response to Northwest Energy comment
    - iii) Bill Herbsleb will provide a response to AEP comment
  - c) Question #15
    - i) Question #15 was partially reviewed. The team will finalize responses at the next meeting.
    - ii) Howard Illian will provide a response to IESO comment
2. Next steps

### **Future Meetings/Conference Call(s)**

1. Next team conference call – Wednesday May 11, 2011 2:00 P.M. – 5:00 P.M. EDT
2. Next team meeting -
  - MISO Office Carmel, IN
  - Wednesday May 18, 2011 8:00 A.M. – 5:00 P.M. EDT
  - Thursday May 19, 2011 8:00 A.M. – 3:00 P.M. EDT

## Meeting Notes Project 2007-12 Frequency Response

May 18, 2011 | 8:00 a.m.–5:00 p.m. ET  
May 19, 2011 | 8:00 a.m.–3:00 p.m. ET

Midwest ISO  
Carmel, IN

### Administrative

#### 1. Introductions and attendance

Attendees: Terry Bilke, MISO; Bill Herbsleb, PJM; Howard Illian, EnergyMark; David Lemmons, Xcel Energy; Carlos Martinez, AS Researchers; Sydney Niemeyer, NRG; Scott Sells, FERC; Bob Cummings, NERC; Darrel Richardson, NERC

Via Conference Call: Don Badly, NWPP; Gerry Beckerle, Ameren; Robert Blohm, Consultant; Matt Cinadr, DPS New York; Mike Potishnak, ISO New England; Sandip Sharma, ERCOT

#### 2. Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Agenda

#### 1. Review Field Trial

- a. Bob Cummings gave an overview of the Field Trial
- b. NERC will provide support in the following areas:
  - i. Provide candidate list of events for selection process
  - ii. Analysis of Interconnection wide Frequency Response for approved events
  - iii. Analysis of Balancing Authority performance
  - iv. Analysis of signal/noise ratio in data
- c. The Standard Drafting Team (SDT) decided that events will be selected and posted monthly
- d. Compliance will be evaluated at least quarterly on a 112 month rolling average

**2. Review FERC Directive (“...define methods for obtaining Frequency Response”)**

- a. Majority of the SDT believed that the directive could be satisfied by listing methods for obtaining Frequency Response.
- b. FERC staff and a few SDT members felt the directive went beyond simply listing methods. They believed the directives intent was to require a System Operator to know where the Frequency Response was coming from at all times.
- c. There was significant discussion on the directive with no definable agreement as to the intent.
- d. Darrel Richardson, Bob Cummings, David Lemmons, and Terry Bilke will hold a conference call with NERC staff to get their opinion as to the intent of the directive and develop an action plan for moving forward.

**3. Review Questions # 9 and 14**

- a. Deferred

**4. Review Draft Standard for Modifications**

- a. Deferred

**5. Review Implementation Plan**

- a. Deferred

**6. Discuss Dates for Possible Webinar (60 minutes)**

- a. Deferred

**7. Review Associated Documents**

- a. Reviewed LeRoy Patterson’s modifications to FRS Form 1
  - i. Corrected errors in calculations
  - ii. Added space for adjustments
- b. Reviewed Mike Potishnak’s response to Howard Illian’s comments on Mike’s paper “Measuring and Calculating Balancing Authority Frequency Response”

**8. Action Items**

- a. Sydney Niemeyer – Develop BA Event Calculation Spreadsheet
- b. Howard Illian – Provide averaging times to Sydney Niemeyer for use in the spreadsheets
- c. Bill Herbsleb
  - i. Finalize FRS Form 1
  - ii. Write instructions for FRS Form 1

**Future Meeting(s)/Conference Call(s)**

1. A face to face meeting was scheduled for June 2-3, 2011 at the FERC offices in Washington, DC
2. A conference call was scheduled for June 17, 2011
3. A conference call was scheduled for July 8, 2011

## Meeting Notes Project 2007-12 Frequency Response

June 2, 2011 | 8:00 a.m.–5:00 p.m. ET

June 3, 2011 | 8:00 a.m.–3:00 p.m. ET

NERC Office  
Washington, DC

### Administrative

#### 1. Introductions and attendance

Attendees: Terry Bilke, MISO; David Lemmons, Xcel Energy; Eddy Lim, FERC; Carlos Martinez, AS Researchers; Mike Potishnak, ISO New England; Scott Sells, FERC; Bob Cummings, NERC; Darrel Richardson, NERC

Conference Call: Robert Blohm, Consultant; Matt Cinadr, DPS New York; Howard Illian, EnergyMark; Sandip Sharma, ERCOT

#### 2. Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Agenda

#### 1. Review of Field Trial

- a. Bob Cummings gave an overview of the data being provided
- b. The Standard Drafting Team (SDT) moved the trigger for candidate events from 750 MW to 1000 MW for the Eastern Interconnection in an attempt to lessen the events to be evaluated (went from 90+ events to 25+ events)

#### 2. Review of FRS Form 1 Revisions

- a. Reviewed Form 1 making no revisions

#### 3. Review of Draft Standard for Modifications

- a. Deferred

#### 4. Review of Implementation Plan

- a. Deferred

5. **Discuss Dates for Possible Webinar (60 minutes)**
  - a. Tentatively set for July 11, 2011 (dependent on availability of Sydney Niemeyer)
6. **Review of Associated Documents**
  - a. Deferred
7. **Action Items**
  - a. Sydney Niemeyer – BA Event Calculation Spreadsheet
  - b. Gerry Beckerle – Review Criteria for Selection of Events
8. **Developed a tentative Field Trial Timeline**
9. **Eddy Lim (FERC) gave an overview of the LBL Report**
10. **Discussion on the FERC directive “...define methods for obtaining FR...”. There was no resolution between the SDT and FERC staff.**

#### **Future Meeting(s)/Conference Call(s)**

1. **A conference call is scheduled for June 17, 2011**
2. **A conference call is scheduled for July 8, 2011**

# Meeting Notes

## Project 2007-12 Frequency Response

July 8, 2011 | 11:00 a.m.–3:00 p.m. ET

Conference Call

### Administrative

#### 1. Introductions and attendance

Attendees: Don Badley, NWPP; Gerry Beckerle, Ameren; Terry Bilke, MISO; Robert Blohm, Consultant; Matt Cinadr, DPS New York; Brad Gordon, PJM; Tom Hauske, PJM; Howard Illian, EnergyMark; David Lemmons, Xcel Energy; Carlos Martinez, AS Researchers; Steve Myers, ERCOT; Sydney Niemeyer, NRG Texas; Mike Potishnak, ISO New England; Scott Sells, FERC; Sandip Sharma, ERCOT; Tom Siegrist, EnerVision; Darrel Richardson, NERC; Ron Verranault, NERC Consultant

#### 2. Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Standard Development

#### 1. Review and Finalize Draft Standard

- a. The Standard Drafting Team (SDT) decided to put the Frequency Bias Setting Definition back into the standard
- b. Requirement R1 – The SDT made minor modifications to the requirement and changed the VRF to “Medium”
- c. Requirement R2 – The SDT made minor modifications to the requirement
- d. Requirement R3 – The SDT made minor modifications to the requirement
- e. Requirement R4 – The SDT made minor modifications to the requirement
- f. Requirement R5 – The SDT accepted the requirement as written
- g. Measure M1 and M2 – The SDT accepted the measures as written
- h. Measure M3 – The SDT made conforming changes to the measure to align with the requirement
- i. Measure M4 and M5 – The SDT accepted the measures as written

**2. Review and Finalize Attachment A**

- a. The SDT made minor modifications the Criteria For Selecting Events
- b. The SDT modified Table 1 to reflect “Under Frequency” and “Over Frequency” values

**3. Review & finalize Background Document**

- a. Deferred to next meeting

**4. Review & finalize FRS Form 1 and Form 2**

- a. Deferred to next meeting

**5. Review & finalize FRS Form 1 and Form 2 Instructions**

- a. Deferred to next meeting

**Future Meetings/Conference Call(s)**

1. A conference call was scheduled for July 11, 2011
2. A webinar was scheduled for July 18, 2011
3. A conference call is scheduled for July 18, 2011 (after the webinar)



## Meeting Notes Project 2007-12 Frequency Response

July 11, 2011 | 1:00–5:00 p.m. ET

Conference Call

### Administrative

#### 1. Introductions and attendance

Attendees: Terry Bilke, MISO; Robert Blohm, Consultant; Brad Gordon, PJM; Tom Hauske, PJM; David Lemmons, Xcel Energy; Carlos Martinez, AS Researchers; Steve Myers, ERCOT; Sydney Niemeyer, NRG Texas; LeRoy Patterson, Patterson Consulting; Mike Potishnak, ISO New England; Scott Sells, FERC; Sandip Sharma, ERCOT; Bob Cummings, NERC; Darrel Richardson, NERC; Ron Verranault, NERC Consultant

#### 2. Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Standard Development

#### 1. Review and Finalize Modifications to Attachment A

- a. Attachment A was extensively discussed and modifications were made by the SDT. The two major modifications included:
  - i. Texas excludes LAARs from calculations
  - ii. FRO Table was modified to better reflect ERCOT limits

#### 2. Review and Finalize Background Document

- a. The document was extensively discussed and modifications were made by the SDT

#### 3. Review Howard Illian and Mike Potishnak Proposal — Overlap Regulation Service

- a. Deferred to later meeting

### Future Meeting(s)/Conference Call(s)

1. A webinar is scheduled for July 18, 2011
2. A conference call is scheduled for July 18, 2011 (after the webinar)
3. A conference call is scheduled for August 4 and 5, 2011

## Meeting Notes Project 2007-12 Frequency Response

August 4, 2011 | 12:00–4:00 p.m. ET

Conference Call

### Administrative

#### 1. Introductions and attendance

Attendees: Larry Akens, TVA; Don Badley, NWPP; Robert Blohm, Consultant; Matt Cinadr, DPS New York; Brad Gordon, PJM; Tom Hauske, PJM; Howard Illian, EnergyMark; David Lemmons, Xcel Energy; Eddy Lim, FERC; Clyde Loutan, CAL ISO; Carlos Martinez, AS Researchers; Sydney Niemeyer, NRG Texas; Mike Potishnak, ISO New England; Scott Sells, FERC; Sandip Sharma, ERCOT; Tom Washburn, FMPP; Darrel Richardson, NERC

#### 2. Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Standard Development

#### 1. Discussion of Quality Review Comments Received

a. The quality review was discussed by the Standard Drafting Team (SDT). The SDT revised requirements based on the comments received.

#### 2. Next Steps

### Future Meeting(s)/Conference Call(s)

1. A conference call was scheduled for August 5, 2011
2. A face to face meeting is scheduled for September 1-2, 2011 in Carmel, IN

## Meeting Notes Project 2007-12 Frequency Response

August 5, 2011 | 10:00 a.m.–2:00 p.m. ET

Conference Call

### Administrative

#### 1. Introductions and attendance

Attendees: Don Badley, NWPP; Robert Blohm, Consultant; Bill Campbell, Exelon; Matt Cinadr, DPS New York; Tom Hauske, PJM; David Lemmons, Xcel Energy; Eddy Lim, FERC; Carlos Martinez, AS Researchers; Sydney Niemeyer, NRG Texas; Scott Sells, FERC; Tom Washburn, FMPP; Darrel Richardson, NERC

#### 2. Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Standard Development

#### 1. Discussion of Quality Review comments received

- a. The Standard Drafting Team (SDT) continued discussion on the quality review. The SDT revised the following documents based on the comments received:
  - i. Standard — Measures and additional compliance information
  - ii. Attachment A — BAL-003-1 Supporting Document
  - iii. Attachment B — BAL-003-1 Process for Adjusting Bias Setting Floor

#### 2. Next Steps

### Future Meeting(s)/Conference Call(s)

1. A conference call was scheduled for August 15, 2011
2. A face to face meeting is scheduled for September 1-2, 2011 in Carmel, IN

## Meeting Notes Project 2007-12 Frequency Response

September 1, 2011 | 8:00 a.m. – 5:00 p.m. ET  
September 2, 2011 | 8:00 a.m. – 12:00 p.m. ET

Carmel, IN

### Administrative

#### 1. Introductions and attendance

Attendees: Larry Akens, TVA; Don Badley, NWPP; Terry Bilke, MISO; Howard Illian, EnergyMark; David Lemmons, Xcel Energy; Eddy Lim, FERC; Clyde Loutan, CAL ISO; Carlos Martinez, AS Researchers; Sydney Niemeyer, NRG Texas; LeRoy Patterson, Patterson Consulting; Mike Potishnak, ISO New England; Leslie Sapornaro, FERC; Scott Sells, FERC; Wayne Van Liere, LGE/KU; Tom Washburn, FMPP; Darrel Richardson, NERC

Via Conference Call: Gerry Beckerle, Ameren; Troy Blalock, SCANA; Robert Blohm, Consultant; Brad Gordon, PJM

#### 2. Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Standard Development

#### 1. TIS Interconnection Frequency Response Obligation (IFRO) Report

Bob Cummings reviewed the TIS Report. The recommendation from the report was to use a value of 1,875 MW for the IFRO versus the RS recommendation of 1,406 MW. Both methods use a higher UFLS setting for the Eastern Interconnection due to the Florida UFLS setting. Howard Illian recommended using the TIS value while Terry Bilke opposed. The Standard Drafting Team (SDT) voted 4 to 3 (with Dave Lemmons and Mike Potishnak abstaining) to use the RS value.

#### 2. Reviewed data submitted by Balancing Authorities

##### a. B measurement Point discussion

The SDT discussed which Bpoint measurement would be the proper one to use. After several minutes of discussion the SDT settled on the 20 – 52 seconds measuring period.

b. Adjustments discussion

The SDT discussed the adjustment section of the Form 1. The SDT was unsure if some of the adjustments should be allowed and was also unsure if they would be used properly. The SDT decided to wait on making any judgments until the BA data had been reviewed.

The SDT reviewed several of the BAs data submitted for the Field Trial. Sydney Niemeyer removed the identity of the BAs due to confidentiality since some of the SDT had not yet signed a Non-Disclosure Agreement. The SDT noted that there appeared to be some discrepancies in the event starting point ( $T_0$ ). Don Badley commented that a few entities in the West were concerned that some of the events identified occurred during schedule ramping periods. The SDT echoed their concerns but felt it was important to review this data to see if there was any legitimate concern of selecting events during these periods. The SDT will continue to evaluate the data received.

**3. Determine methodology for calculating Frequency Response Obligation — this was deferred until a later meeting**

**4. Determine methodology for calculating Frequency Response Measure — this was deferred until a later meeting**

**5. Next steps**

- a. The SDT decided to hold a Webinar to discuss the proposed standard and their finding from the data received. The tentative date for the Webinar is November 8, 2011. The SDT also recommended having the NERC RS reach out to the BAs to ensure they know about the Webinar.
- b. The SDT made the following assignments:
  - i. Sydney Niemeyer will continue reviewing the BA data for accuracy.
  - ii. Howard Illian and Mike Potishnak will provide summaries of the methodologies for calculating FRM (mean, median, regression, etc.).
  - iii. Terry Bilke will provide an updated copy of the Attachment B – Background Document.

**Future Meeting(s)/Conference Call(s)**

- 1. A conference call was scheduled for September 26, 2011**

# Meeting Notes

## Project 2007-12 Frequency Response

September 26, 2011 | Noon to 4:00 p.m. ET  
Conference Call

### Administrative

#### 1. Introductions and Chair's Remarks

David Lemmons opened the meeting. Mr. Lemmons informed the group that he did not believe the meeting would need to last the full four hours.

#### 2. Attendance

Name	Entity
Gerry Beckerle	Ameren
Robert Blohm	Consultant
Brad Gordon	PJM
Tom Hauske	PJM
Howard Illian	Energy Mark
David Lemmons	Xcel Energy
Eddy Lim	FERC
Carlos Martinez	CERTS
Sydney Niemeyer	NRG
Mike Potishnak	ISO NE
Darrel Richardson	NERC
Scott Sells	FERC
Sandip Sharma	ERCOT
Ron Verranault	Consultant

#### 3. Participants were read the NERC Antitrust Compliance Guidelines and public announcement

## Agenda Items

### 1. Discuss Field Trial

- a. Sydney Niemeyer stated that he had evaluated the data submitted by the Balancing Authorities (BAs) from the Eastern Interconnection, Hydro Quebec and ERCOT. He has not completed review of the data from the Western Interconnection. He said that it appeared that many of the BAs were not reading the instructions as there were many errors. He also stated that he had rebuilt Form 1 due to some calculation errors. A couple of the BAs did not submit Form 2 due to confidentiality reasons.
- b. The Standard Drafting Team (SDT) reconfirmed that the 20 to 52 second interval was the proper one to use for the B Point.
- c. The SDT also recommended that the measure needed to be a multiple event measure and not a single event measure. Howard Illian is preparing a paper to discuss this issue.

### 2. Standard Development

Robert Blohm suggested some wording modifications to the event selection criteria. The SDT decided to not use Mr. Blohm's suggestions.

### 3. Next Steps

The SDT is to review the IFRO and FRM methodologies and the associated standards documents and provide any further comments.

### 4. Future Meeting(s)/Conference Call(s)

None were set.

### 5. Adjourn

# Meeting Notes

## Project 2007-12 Frequency Response

December 14, 2011 | 8:00 a.m. to 5:00 p.m. ET  
December 15, 2011 | 8:00 a.m. to 2:00 p.m. ET

NERC Headquarters  
Atlanta, GA

### Administrative

#### 1. Introductions and chair's remarks

David Lemmons welcomed everyone and thanked them for attending.

#### 2. Attendance

Name	Entity	In-person/Via Conference Call
Don Badley	NWPP	In-person
Gerry Beckerle	Ameren	In-person
Terry Bilke	MISO	In-person
Troy Blalock	SCANA	In-person
Robert Blohm	Consultant	Conference Call
Neil Burbure	FERC	In-person
Howard Illian	Energy Mark	Conference Call
David Lemmons	Xcel Energy	In-person
Carlos Martinez	CERTS	Conference Call
Sydney Niemeyer	NRG	In-person
Mike Potishnak	ISO NE	In-person
Darrel Richardson	NERC	In-person
Scott Sells	FERC	In-person

#### 3. Participants were read the NERC Antitrust Compliance Guidelines and public announcement



## Agenda Items

### 1. Standard development

- a. Review comments received from second posting and initial ballot.
  - i. The Standard Drafting Team (SDT) reviewed and discussed the comments received from the industry. The SDT identified the following major issues brought out by the industry:
    1. The Balancing Authority (BA) does not control the generator
    2. How Frequency Response (FR) is measured
    3. Measurement noise (i.e., single event vs. multiple event)
    4. FR vs. Frequency Bias
    5. Maximum FR expectation
    6. Use of Reserve Sharing Groups (RSG)
- b. Develop responses to comments received.
  - i. Question #1
    1. The SDT developed conceptual thoughts to respond to comments received.
    2. Some commenters felt the definitions for Frequency Response Measure and Frequency Response Obligation (FRO) should be removed and rolled into the requirements. The SDT disagreed with removing the definitions but felt that they should be reviewed to determine if modifications would provide additional clarity.
  - ii. Question #2
    1. The SDT developed conceptual thoughts to respond to comments received.
    2. Mr. Lemmons will provide language to limit the amount of FR a BA has to provide for compliance.
    3. The SDT created a definition for Frequency Response Sharing Group (FRSG) to eliminate confusion with responsibilities of an RSG.
    4. The SDT will evaluate options for modifying Requirement R5 to provide additional clarity.
    5. The SDT is reviewing the implementation period for Frequency Bias Setting.
    6. The SDT will review Requirement R3 for use of the term "Tie Line Bias Mode".
  - iii. Question #10
    1. The SDT developed conceptual thoughts to respond to comments received.

2. The SDT will review the language associated with the timing of providing the data for the events developed by the Electric Reliability Organization (ERO).
  3. The SDT will review the issue associated with FR during emergency operations vs. normal operations.
  - iv. Question #6
    1. The SDT developed conceptual thoughts to respond to comments received.
    2. The SDT will make modifications to clarify that the ERO is responsible for setting the Interconnection Frequency Response Obligations and FRO.
2. **Next Steps – The following assignments were made:**
- a. Preliminary responses to remaining questions:
    - i. Question #3 – Darrel Richardson
    - ii. Question #5 – Terry Bilke
    - iii. Question #6 – Darrel Richardson (finish)
    - iv. Question #7 – David Lemmons
    - v. Question #8 – Don Badley
    - vi. Question #9 – Sydney Niemeyer
  - b. The following individuals will provide additional language to support the following Issues:
    - i. RSG vs. FRSG – Mike Potishnak, Terry Bilke and Don Badley
    - ii. Median measure – Mike Potishnak and Howard Illian
    - iii. Primary response – Gerry Beckerle
    - iv. Responsibilities to generators – Sydney Niemeyer and Troy Blalock
    - v. Removal of Tie Line Bias operation requirement – Don Badley
    - vi. Fixed Bias versus Variable Bias – Don Badley, Terry Bilke, Sydney Niemeyer and Mike Potishnak
    - vii. Maximum FR responsibility – David Lemmons
3. **Future meeting(s)/conference call(s)**  
None were set.
4. **Adjourn**

## **Attachment G**

### **Frequency Response Standard Drafting Team Meeting Minutes, 2012**

## Meeting Notes

### Project 2007-12 Frequency Response

January 9, 2012 | 1:00 to 5:00 p.m. ET  
Conference Call

#### Administrative

##### 1. Introductions and chair's remarks

David Lemmons welcomed everyone.

##### 2. Attendance

Name	Entity
Don Badley	NWPP
Gerry Beckerle	Ameren
Terry Bilke	MISO
Robert Blohm	Consultant
Neil Burbure	FERC
Brad Gordan	PJM
Howard Illian	Energy Mark
David Lemmons	Xcel Energy
Carlos Martinez	CERTS
Sydney Niemeyer	NRG
Mike Potishnak	ISO NE
Darrel Richardson	NERC
Sandip Sharma	ERCOT
Tom Washburn	OUC

##### 3. Participants were read the NERC Antitrust Compliance Guidelines and public announcement

## Agenda Items

### 1. Standard development

- a. Review Standard Drafting Team (SDT) responses to issues (see attached document)
  - i. Reserve Sharing Groups vs. Frequency Response Sharing Group – The SDT reviewed the responses and agreed with the proposal.
  - ii. Median measure – The SDT reviewed the responses provided and decided to expand on it. The Background Document will be revised to include the new additional language.
  - iii. Responsibilities to generators – The SDT reviewed the responses and agreed with the proposal.
  - iv. Removal of Tie Line Bias operation requirement – The SDT agreed with the proposed responses for removal of Requirement R3.
  - v. Fixed Bias versus Variable Bias – The SDT reviewed the response provided by Terry Bilke and agreed that it needed additional language. Sydney Niemeyer will provide additional language.
  - vi. Maximum Frequency Response responsibility – The SDT reviewed the proposed language provided by David Lemmons and decided to modify it slightly. The new language will be added to the selection criteria.
- b. Review SDT responses to comments (See attached documents)
  - i. The SDT reviewed the proposed responses for the following questions:
    1. Question #5 – The SDT reviewed and agreed with the proposed wording. The SDT also felt that some modifications needed to be made based on the comments.
      - a. The SDT will modify the language in Requirement R1 and the associated Violation Security Levels (VSLs).
      - b. The SDT agreed with the modification suggested by Southern Company for the VSL for Requirement R2 and will modify them.
      - c. The SDT agreed with SWPP that an explanation on how the VSL for Requirement R1 should work would be beneficial and will provide said explanation.
    2. Question #7 – The SDT reviewed the proposed responses and agreed with the proposed wording with some slight modifications. The SDT also felt that some modifications to the draft standard documents needed to be made based on the comments.
      - a. The SDT disagreed with NPCC's concern with the use of Supplemental Regulation Service. Mike Potishnak will draft a response.
      - b. The SDT will modify the Background Document to address the concerns brought to light by MRO NSRF.

- c. The SDT will correct the Background Document and Attachment A to ensure that they reflect the same language.
3. Some commenters felt the definitions for Frequency Response Measure and Frequency Response Obligation should be removed and rolled into the requirements. The SDT disagreed with removing the definitions but felt that they should be reviewed to determine if modifications would provide additional clarity.

## 2. **Next steps**

The SDT will continue reviewing the comments received and discuss during the conference call scheduled for January 13, 2012.

## 3. **Future meeting(s)/conference call(s)**

- a. Conference call – January 13, 2012
- b. January 18-20, 2012, NRG Office in Houston, TX

## 4. **Adjourn**

## Meeting Notes

### Project 2007-12 Frequency Response

January 13, 2012 | 10:00 a.m. to 2:00 p.m. ET  
Conference Call

#### Administrative

##### 1. Introductions and chair's remarks

David Lemmons opened the meeting.

##### 2. Attendance

Name	Entity
Don Badley	NWPP
Gerry Beckerle	Ameren
Terry Bilke	MISO
Troy Blalock	SCANA
Robert Blohm	Consultant
Neil Burbure	FERC
Brad Gordan	PJM
Tom Hauske	PJM
Howard Illian	Energy Mark
David Lemmons	Xcel Energy
Carlos Martinez	CERTS
Sydney Niemeyer	NRG
Mike Potishnak	ISO NE
Darrel Richardson	NERC
Tom Washburn	OUC

##### 3. Participants were read the NERC Antitrust Compliance Guidelines and public announcement

## Agenda Items

### 1. Standard development

- a. The Standard Drafting Team (SDT) reviewed the proposed responses to comments for the following questions:
  - i. Question #8 – The SDT reviewed and agreed with the proposed wording. The SDT also felt that some modifications needed to be made based on the comments.
    1. The SDT agreed with the MRO NSRF suggestion to provide clarity in the wording of Attachment B. The SDT will modify the language.
    2. The SDT understood the concern raised by Duke energy on the possible side effects of reducing the minimum Frequency Bias Setting. Don Badley will provide a response explaining why the SDT is proposing a “go slow” approach with checks to ensure that there are no negative effects from the reduction.
    3. Howard Illian and Gerry Beckerle will provide additional language to support the SDT’s position with regards to the Tucson Electric response.
    4. Sydney Niemeyer will draft language to respond to the Hydro Quebec concern regarding Variable Bias.
    5. The SDT will modify the language to provide additional clarity concerning the reduction of the minimum Bias Setting raised by FPL.
  - ii. Question #9 – The SDT reviewed and agreed with the proposed wording. The SDT also felt that some modifications needed to be made based on the comments.
    1. Removal of Tie Line Bias operation requirement – The SDT agreed with the proposed responses for removal of Requirement R3.
    2. The SDT felt that additional language was needed for the response to BPA concerning Form 2 being complex and difficult to understand. Darrel Richardson will provide the modification.
- b. Modify documents (if necessary)
- c. Other documents (?)

### 2. Next steps

None noted at this time.

### 3. Future meeting(s)/conference call(s)

January 18-20, 2012, NRG Office in Houston, TX

### 4. Adjourn



## Meeting Notes Project 2007-12 Frequency Response and Frequency Bias

Wednesday January 18, 2012 | 8:00 a.m. – 5:00 p.m.

Thursday January 19, 2012 | 8:00 a.m. – 5:00 p.m.

Friday January 20, 2012 | 8:00 a.m. – 12:00 p.m.

NRG Energy, Inc.

1201 Fannin

Houston, TX 77002

Dial-in: 866.740.1260 | Acces Code: 6131848 | Security Code: 13579

### Introductions and Chair's Remarks

1. Dave Lemmons opened the meeting and thanked everyone for coming to Houston, TX.
2. Attendees: Terry Bilke, MOISO; Carlos Martinez, CERTS; Gerry Beckerle, Ameren; Neil Burbure, FERC; Sydney Niemeyer, NRG; David Lemmons, Excel Energy; Mike Potishnak, ISO NE; Sandip Sharma, ERCOT; Bob Cummings, NERC; Don Badley, NWPP; Darrel Richardson, NERC.
3. Attendees – Conference call: Howard Illian, Energy Mark; Tom Washburn, OUC; Troy Blalock, SCANA; Robert Blohm, Consultant.

### Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Review Agenda

1. Dave Lemmons reviewed the agenda. No additions were made.

### Standard Development

1. Review Howard/Mike Paper (see attached)
  - a. The SDT reviewed the paper, "Discussion of the Preliminary Choice of the Median as the Sampling Aggregate Technique", prepared by Howard Illian and Mike Potishnak. The SDT agreed with the paper and asked them to make sominor modifications. The SDT thanked them for the work they provided.
2. Variable Bias Issue
  - a. The SDT discussed the use of Variable Bias. Sydney Niemeyer stated that using Variable Bias benefitted both the BA and the Interconnection. Sydney will provide language for the requirement to be inserted in the proposed standard.
3. Generator response issue

- a. The SDT discussed the BA/Generator issue. The SDT felt that there was really nothing they could do to completely resolve the issue within the time frame allotted. The SDT agreed on a response to be inserted into the comment report.
4. Review Background Document (see attached)
  - a. The SDT proposed corresponding changes to the Background Document to align with the modifications to the proposed standard and attachments. The SDT also made minor modifications to the document to provide for further clarity.
5. Review Attachment A (see attached)
  - a. The SDT modified the Attachment A to reflect changes suggested from the industry comment period. The SDT discussed the methodology proposed to calculate the BA FRO. The attachment will be modified to reflect the information located within the Background Document that further defines the variable used in the calculation. The SDT also made minor modifications based on industry feedback from the comment period.
6. Review Attachment B (see attached)
  - a. The SDT modified the Attachment B to reflect suggest modifications from the industry during the comment period. These changes include:
    - i. Added language to reflect the use of variable Frequency Bias.
    - ii. Removed the “minimum Frequency Bias Setting” from ERCOT and Hydro Quebec. The SDT felt that these Balancing Authorities were solely responsible for providing reliable frequency control of their Interconnection. These Balancing Authorities are responsible for converting frequency error into a megawatt error to provide reliable frequency control, and the imposition of a minimum bias setting may have the potential to cause control system hunting, and instability in the extreme.
    - iii. Revised the language detailing the process for determining wheter the ERO should lower the minimum Frequency Bais Setting to provide additional clarity.
7. Review and modify Standard (see attached)
  - a. The SDT made the following modifications to the proposed standard.
    - i. Modified the definition for FRM to no longer reference a form to be used. Language was added to Attachment A and the Background Document to require the use of the forms (FRS Form 1 and FRS Form 2).
    - ii. Created a definition for Frequency Response Sharing Group. The SDT agreed with the industry that using the term Reserve Sharing Group created confusion with other standards.
    - iii. Modified Requirement R1 to provide additional clarity.
    - iv. Modified Requirement R2 to allow for an implementation period and provide additional clarity.
    - v. Removed Requirement R3 (use of Tie Line Bias mode). The SDT felt that this was duplicative of requirement in BAL-005-0.1b Requirements R6 and R7.
    - vi. Created a requirement for entities choosing to use Variable Frquency Bias.

- vii. Modified the measures and VSLs to align with the proposed modifications to the requirements.
- 8. Review Response to Comments
  - a. Due to time constraints the review of the Response to Comments will be done via e-mail and if necessary will be discussed on a conference call.
- 9. Robert Blohm disagreed with the use of an RSG for complying with the proposed Requirement R1. Robert felt that using a RSG could give a competitive advantage and create the possibility of collusion. The SDT disagreed with Robert and voted to keep the RSG as a possible method for compliance. Robert felt that his objection should be posted with the documents for industry review. Again, the SDT disagreed that this should be posted with the documents for industry review and ballot. The SDT felt that his objection should be added to the meeting notes and posted on the NERC website. Robert disagreed and invoked the Antitrust Compliance Guidelines. The meeting was stopped until this could be addressed by either NERC management or NERC legal. Andy Rodriguez was notified and called into the meeting to inform everyone that somebody from NERC legal would be in touch shortly. Andrew Dressel (NERC legal) called into the meeting to discuss the issue. He found that there was not an Antitrust issue involved and informed the group of this.
- 10. Next Steps – The following assignments were made.
  - a. Howard Illian will combine the description of Primary Frequency Response, provided by Gerry Beckerle, and the paper developed by Howard Illian and Mike Potishnak describing the reason for selecting the median and the proper measure into the Background Documents.
  - b. Carlos Martinez will provide an updated graph reflecting a generator trip for Howard to include in the Background Document.
  - c. Darrel Richardson will “clean up” all the documents and send them to the SDT for review prior to sending them in for Quality Review.

#### 4. Future Meetings/Conference Call(s)

- a. The SDT decided to set the following dates for conference calls to address comments from the Quality review.
  - i. Monday February 6, 2012 1:00 p.m. – 5:00 p.m. ET
  - ii. Wednesday February 8, 2012 1:00 p.m. – 5:00 p.m. ET
  - iii. Friday February 10, 2012 10:00 a.m. – 2:00 p.m. ET
- b. The SDT set the following dates for a possible meeting to review comments from the third posting and second initial ballot. The exact date and location will be determined once the documents are posted.
  - i. Tuesday March 20, 2012 through Thursday March 22, 2012
  - ii. Wednesday March 28, 2012 through Friday March 30, 2012

**5. Adjourn**

# Agenda

## Project 2007-12–Frequency Response

February 6, 2012 | 1:00 p.m. – 5:00 p.m. ET  
Conference Call

Dial-in: 866.740.1260 | Acces Code: 6131848 | Security Code: 13579

### Introductions and Chair's Remarks

1. David Lemmons opened the meeting.
2. Attendees: David Lemmons, Excel Energy; Henry King, NERC; Gerry Beckerle, Ameren; Neil Burbure, FERC; Brad Gordon, PJM; Howard Illian, Energy Mark; Sydney Niemeyer, NRG; Sandip Sharma, ERCOT; Troy Blalock, SCANA; Robert Blohm, Consultant; Thomas Hauske, PJM; Clyde Loutan, California ISO; Terry Bilke, MISO; Guy Quintin, Hydro Quebec; Carlos Martinez, CERTS; Mike Potishnak, ISO NE; Darrel Richardson, NERC.

### Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Standard Development

1. Minimum Variable Bias Issue – Guy Quintin
  - a. Guy Quintin provided a presentation on why a single BA interconnection should be excluded from a requirement for a minimum Frequency Bias Setting when using Variable Bias. Guy stated that a single BA interconnection had the sole responsibility for maintaining Frequency Response and that that lowering the minimum Frequency Bias Setting for a single BA interconnection would slow the AGC. Howard Illian disagreed. The SDT voted to accept Guy's proposal and remove part of the requirement. Mike Potishnak will provide revised language for the requirement prior to the next call.
2. Review comments from Quality Review (see attached)
  - a. The SDT reviewed the Quality Review comments for the proposed standard. The SDT took the following actions on the comments:
    - i. Comment MEL1 – The SDT accepted the suggestion.
    - ii. Comment BN2 – The SDT accepted the suggestion and will modify the language.
    - iii. Comment MEL3 – The SDT accepted the suggestion and will modify the language.
    - iv. Comment BN4 – The SDT accepted the suggestion.
    - v. Comment BN5 – The SDT accepted the suggestion.
    - vi. Comment BN6 – The SDT accepted the suggestion.

- vii. Comment BN7 & BN8 – The SDT accepted the part of the suggestion. The SDT did not agree that any further discussion was necessary for flat frequency control.
  - viii. Comment MEL9 – The SDT accepted the suggestion.
3. Next Steps – DarrelRichardson will make the proposed changes to the documents prior to the call on Wednesday February 8, 2012.

## 2. **Future Meetings/Conference Call(s)**

- a. Conference Call – Address comments received from Quality Review
  - i. Wednesday February 8, 2012 1:00 p.m. – 5:00 p.m. ET
  - ii. Friday February 10, 2012 10:00 a.m. – 2:00 p.m. ET
- b. Meeting (tentative - Address comments received from posting) – Location TBD
  - i. Tuesday March 20, 2012 – Thursday March 22, 2012
  - ii. Wednesday March 28, 2012 – Friday March 30, 2012

## 3. **Adjourn**

# Meeting Notes

## Project 2007-12–Frequency Response

February 8, 2012 | 1:00 p.m. – 5:00 p.m. ET  
Conference Call

Dial-in: 866.740.1260 | Acces Code: 6131848 | Security Code: 13579

### Introductions and Chair's Remarks

1. David Lemmons opened the meeting.
2. Attendees: David Lemmons, Excel Energy; Henry King, NERC; Gerry Beckerle, Ameren; Neil Burbure, FERC; Brad Gordon, PJM; Howard Illian, Energy Mark; Sydney Niemeyer, NRG; Sandip Sharma, ERCOT; Wayne Van Liere, LG&E; Robert Blohm, Consultant; Carlos Martinez, CERTS; Tom Washburn, OUC; Mike Potishnak, ISO NE; Ena Agbedia, FERC; Darrel Richardson, NERC.

### Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Standard Development

1. Review Mike Potishnak proposal for Requirement R3 (see attached)
  - a. The SDT reviewed Mike's proposed justification for removing the requirement for a single BA to have a minimum FBS. The SDT accepted Mike's proposed language.
  - b. Darrel Richardson will provide revised language for Requirement R3 prior to the next call.
2. Review comments from Quality Review
  - a. The SDT reviewed the suggestion from Henry King to turn Attachment B into a Procedure. The reason for making this change is that it would provide an easier method to modify the document in the event something changed. If the document were kept as an attachment to the standard then it would have to go through the entire Standard Development Process to make any modifications. The modification process would be outlined at the beginning of the Procedure. It was also decided to remove the section of Attachment A that deals with the Event Selection Criteria and add it to the Procedure.
3. Review Background Document
  - a. The SDT reviewed the suggested modification made by Howard Illian. The SDT accepted Howard's proposed changes/additions. The SDT also made minor modifications to provide additional clarity.
4. Review Attachment A

- a. The SDT made minor modifications to provide additional clarity.
- 5. Review Attachment B
  - a. See Item 2.a. The Sdt also made minor modifications to provide additional clarity.
- 6. Review Response to Comments Document
- 7. Next Steps – Darrel Richardson will make all suggested modifications to the documents prior to the next call.

## 2. **Future Meetings/Conference Call(s)**

- a. Conference Call – Address comments received from Quality Review
  - i. Friday February 10, 2012 10:00 a.m. – 2:00 p.m. ET
- b. Meeting (tentative - Address comments received from posting) – Location TBD
  - i. Tuesday March 20, 2012 – Thursday March 22, 2012
  - ii. Wednesday March 28, 2012 – Friday March 30, 2012

## 3. **Adjourn**



## Meeting Notes Project 2007-12–Frequency Response

Friday February 10, 2012 | 10:00 a.m. – 2:00 p.m. ET  
Conference Call

Dial-in: 866.740.1260 | Acces Code: 6131848 | Security Code: 13579

### Introductions and Chair's Remarks

1. Divid Lemmons opened the meeting.
2. Attendees: David Lemmons, Excel Energy; Henry King, NERC; Gerry Beckerle, Ameren; Neil Burbure, FERC; Brad Gordon, PJM; Howard Illian, Energy Mark; Sydney Niemeyer, NRG; Sandip Sharma, ERCOT; Wayne Van Liere, LG&E; Robert Blohm, Consultant; Carlos Martinez, CERTS; Troy Blalock, SCANA; Mike Potishnak, ISO NE; Don Badley, NWPP; Darrel Richardson, NERC.

### Participants were read the NERC Antitrust Compliance Guidelines and Public Announcement

### Standard Development

1. Review Background Document (see attached)
  - a. The SDT reviewed the Background Document and accepted as written.
2. Review Attachment A (see attached)
  - a. The SDT reviewed the attachment and made minor modifications.
3. Review Procedure/Attachment B (see attached)
  - a. The SDT reviewed the Procedure and made minor modifications.
4. Review Response to Comments Document (see attached)
  - a. The SDT reviewed the Response to Comments document and made modifications as outline in the QR Comment document (see attached)
5. Next Steps – Darrel Richardson will make all suggested modifications and prepart the documents for return to the Quality Review group.

### 2. Future Meetings/Conference Call(s)

- a. Conference Call –
  - i.
- b. Meeting (tentative - Address comments received from posting) – Location TBD
  - i. Tuesday March 20, 2012 – Thursday March 22, 2012

ii. Wednesday March 28, 2012 – Friday March 30, 2012

3. **Adjourn**