UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

North American Electric Reliability Corporation	**)** **)** **)**	**Docket No. RM13-11-000**

INFORMATIONAL FILING OF THE NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

The North American Electric Reliability Corporation ("NERC") hereby submits this informational filing ("Informational Filing") to the Federal Energy Regulatory Commission ("Commission") as directed in Order No. 794.[1] In Order No. 794, the Commission approved Reliability Standard BAL-003-1 (Frequency Response and Frequency Bias Setting) and directed NERC to submit an informational filing after implementation of the standard, "addressing: (1) an evaluation of the use of the linear regression methodology to calculate frequency response; and (2) the availability of resources for applicable entities to meet the Frequency Response Obligation."[2] As discussed in this Informational Filing and detailed in the attached *Technical Report on NERC Standard BAL-003-1.1* ("Report"), the record demonstrates that: (1) the median method of calculating the Frequency Response Measure ("FRM") continues to provide more accurate results than the linear regression method; and (2) that sufficient frequency response resources existed in 2017 for applicable entities to meet their Frequency Response Obligation ("FRO").

In addition, data indicates that Reliability Standard BAL-003-1.1 has improved reliability by supporting recovery from frequency deviations. The Report summarizes lessons learned and

[1] *Frequency Response and Frequency Bias Setting Reliability Standard*, Order No. 794, 146 FERC ¶ 61,024 (2014).

[2] *Id.* at P 3. Prior filings in compliance with other directives in Order No. 794 have been submitted in the above captioned docket.

opportunities for enhancement being examined by the Standard Drafting Team ("SDT") developing modifications to Reliability Standard BAL-003-1.1 and by NERC technical committees. Together with industry, NERC will continue examining frequency response and potential modifications to Reliability Standards, as appropriate. NERC submits this Informational Filing in compliance with all remaining directives related to Order No. 794.

I. NOTICES AND COMMUNICATIONS

Notices and communications regarding this filing may be addressed to the following:[3]

Shamai Elstein*
Senior Counsel
Candice Castaneda*
Counsel
North American Electric Reliability Corporation
1325 G Street, N.W., Suite 600
Washington, DC 20005
(202) 400-3000
shamai.elstein@nerc.net
candice.castaneda@nerc.net

James Merlo*
Vice President, Reliability Risk Management
North American Electric Reliability Corporation
3353 Peachtree Road, N.E.
Suite 600, North Tower
Atlanta, GA 30326
(404) 446-9705
James.Merlo@nerc.net

Howard Gugel*
Director of Standards
North American Electric Reliability Corporation
3353 Peachtree Road, N.E.
Suite 600, North Tower
Atlanta, GA 30326
(404) 446-2560
Howard.Gugel@nerc.net

[3] Persons to be included on the Commission's service list are identified by an asterisk. NERC respectfully requests a waiver of Rule 203 of the Commission's regulations, 18 C.F.R. § 385.203 (2018), to allow the inclusion of more than two persons on the service list in this proceeding.

II. COMMENTS

A. The Median Method of Calculating the FRM

In Order No. 794, the Commission stated that:

> [T]he Commission acknowledges NERC's commitment to studying the use of linear regression and the analysis contained in the Frequency Response Initiative Report, and directs NERC to continue its evaluation of the use of the linear regression methodology based upon experience and data collected following the implementation of BAL-003-1 and to submit a report to the Commission …. The report should assess the accuracy of the linear regression methodology compared to the median methodology for purposes of determining Frequency Response Measure.[4]

As detailed in the attached Report, data demonstrates that the median method of calculating the FRM continues to provide more accurate results than the linear regression method. To complete its statistical analysis, NERC compared the Interconnection Frequency Response Performance Measure ("IFRM") for each BAL-003-1.1 frequency event in the 2017 operating year,[5] against aggregate performance for all Balancing Authorities ("BAs") in the Interconnection for the same event as calculated under (1) the median method; and (2) the linear regression method. Under this statistical analysis, the method producing the outcome closest to 1.0 compared to the IFRM was considered to provide a better quality measurement.[6] NERC ran this comparison of the IFRM to aggregated BA FRMs as calculated under the median and linear regression methods for the Eastern, Western, and Texas Interconnections. For each Interconnection evaluated, the median method led to results closest to 1.0. Thus, NERC determined that the median method is the most accurate means of calculating the FRM under the current standard.

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[4] Order No. 794 at P 34.

[5] The first operating year that Requirement R1 was effective.

[6] The IFRM was used to benchmark accuracy of BA FRMs in this manner, because the IFRM is considered the most accurate calculation of frequency response performance in an Interconnection for any single BAL-003-1.1 frequency event as the IFRM does not include variables such as tie line error.

B. Adequacy of Frequency Response Resources in the First Year of Implementation of the Standard

In Order No. 794, the Commission:

> [D]irect[ed] NERC to submit a report that provides an analysis of the availability of resources for each balancing authority and Frequency Response Sharing Group to meet its Frequency Response Obligation during the first year of implementation…. The required report should provide data indicating whether actual frequency response was sufficient to meet each balancing authority's Frequency Response Obligation.[7]

NERC has determined that adequate frequency response resources existed in 2017 for each BA to meet the FRO.[8] NERC reached this conclusion after evaluating the 2017 operating year results for Interconnections in the U.S. In the Texas Interconnection, the BA's FRM performance exceeded the FRO. For the Eastern and Western Interconnections, NERC evaluated BA frequency event data submitted for the 2017 operating year to assess whether a BA's percentage of total Interconnection generation was less than their percentage of the total IFRO. In the Western Interconnection, none of the 38 BA's FRM performance failed to meet the FRO.[9] In the Eastern Interconnection, 32 out of the 34 BAs had FRM performance satisfying the FRO. Only two BAs failed to have FRM performance meeting the FRO. These two BAs appear to have been outliers, however, as they were small BAs with combined FROs of less than 0.1% of the total IFRO of the Interconnection and did not use transferred frequency response to help meet their obligation. NERC will continue monitoring this issue.

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[7] Order No. 794 at P 60.

[8] Operating year 2017 was the first year of implementation for Requirement R1 of Reliability Standard BAL-003-1.1.

[9] Out of this group, 11 transferred frequency response from another BA during at least one event to support compliance with the standard.

C. The Report Summarizes Efforts to Further Address Issues Related to Frequency Response

As detailed in the Report, NERC is building on Reliability Standard BAL-003-1.1 to further address issues related to Frequency Response. The SDT for NERC Standards Project 2017-01 is evaluating potential modifications of NERC Reliability Standards in light of lessons learned under Reliability Standard BAL-003-1.1, the changing resource mix, inverter based resource penetration, altered dispatch patterns, and issues surrounding resource availability versus capability. Revisions to NERC Reliability Standards are being pursued over two phases to support continued progress towards enhanced reliability. Subject to completion of the standards development process and NERC Board of Trustees approval, NERC plans to submit the initial phase of modifications to Reliability Standard BAL-003-1.1 in 2019. In addition to SDT work, NERC will continue to coordinate with and rely on technical committee analysis of matters related to Frequency Response. The Resources Subcommittee of the Operating Committee, for example, has taken an active role over the past four years supporting NERC's implementation of the standard and its evaluation of frequency response matters.

III. CONCLUSION

Wherefore, as detailed in the Report, NERC's analysis demonstrates that: (1) the median method for calculating the FRM continues to provide more accurate results than the linear regression method; and 2) sufficient resources were available in operating year 2017 to support applicable entity FROs. NERC is continuing to build on the progress made in Reliability Standard BAL-003-1.1 through two phases of revisions to the standard and strong industry coordination. NERC submits this informational filing as compliant with the Commission's remaining directives in Order No. 794.

Respectfully submitted,

/s/ Candice Castaneda

Shamai Elstein
Senior Counsel
Candice Castaneda
Counsel
North American Electric Reliability Corporation
1325 G Street, N.W., Suite 600
Washington, DC 20005
(202) 400-3000
shamai.elstein@nerc.net
candice.castaneda@nerc.net

Counsel for the North American Electric Reliability Corporation

Date: June 29, 2018

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 29th day of June 2018.

/s/ Candice Castaneda

Candice Castaneda
Counsel
North American Electric Reliability Corporation
1325 G Street, N.W., Suite 600
Washington, DC 20005
(202) 400-3000
candice.castaneda@nerc.net

Counsel for North American Electric Reliability Corporation

Attachment

Technical Report on NERC Standard BAL-003-1.1

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Technical Report on NERC Standard BAL-003-1.1

Informational Filing in Compliance with FERC Order 794

June 29, 2018

RELIABILITY | ACCOUNTABILITY




3353 Peachtree Road NE
Suite 600, North Tower
Atlanta, GA 30326
404-446-2560 | www.nerc.com

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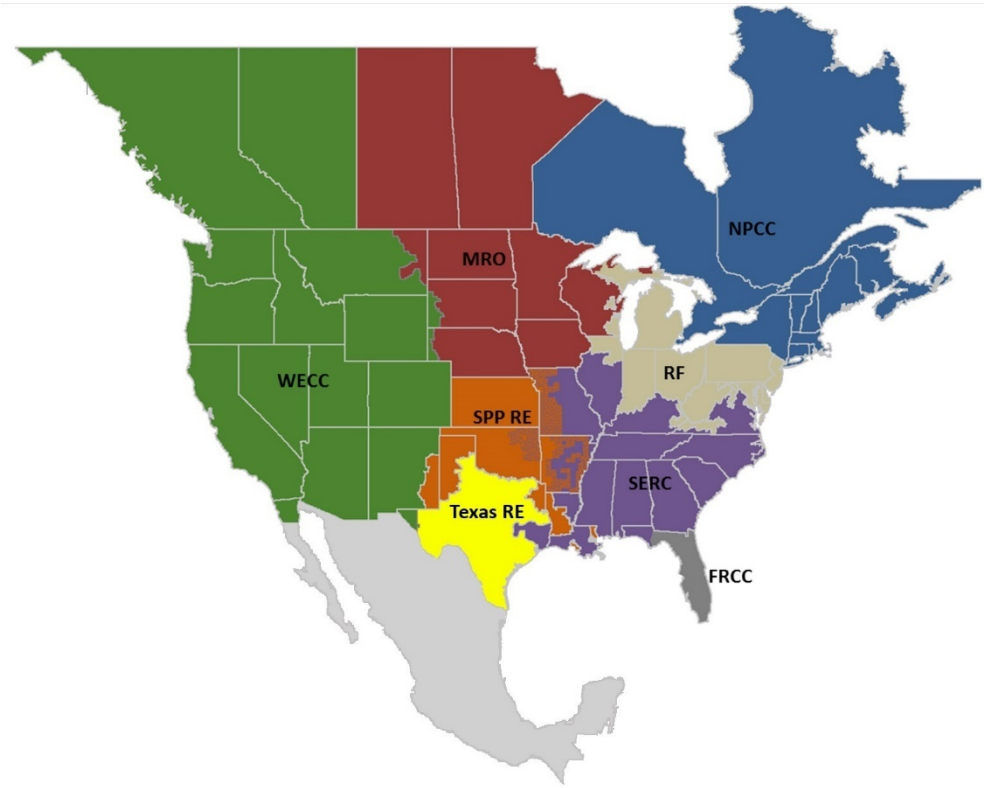
Preface

The vision for the Electric Reliability Organization (ERO) Enterprise, which is comprised of the North American Electric Reliability Corporation (NERC) and the eight Regional Entities (REs), is a highly reliable and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

The North American BPS is divided into eight RE boundaries as shown in the map and corresponding table below. The highlighted areas denote overlap as some load-serving entities participate in one Region while associated Transmission Owners/Operators participate in another.



FRCC	Florida Reliability Coordinating Council
MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
SPP RE	Southwest Power Pool Regional Entity
Texas RE	Texas Reliability Entity
WECC	Western Electricity Coordinating Council

Executive Summary

In Order No. 794, the Federal Energy Regulatory Commission (FERC or Commission) approved *Reliability Standard BAL-003-1* and issued certain directives for an informational filing describing the results of implementation of the standard.[1] In the Order, the Commission directed NERC to do the following:

> "…submit a report(s) addressing: (1) an evaluation of the use of the linear regression methodology to calculate frequency response; and (2) the availability of resources for applicable entities to meet the Frequency Response Obligation." [2]

NERC is submitting this report to satisfy those directives and prepared it by using frequency response performance data submitted by Balancing Authorities (BAs) in the Eastern Interconnection (EI), Western Interconnection (WI), and Texas Interconnection (TI) for the 2017 operating year[3] in accordance with BAL-003-1.1 Key findings and recommendations from the analysis described below are examined in this report and summarized in this executive summary.

Response to Order No. 794 Directives

The following are the findings and recommendations pertaining to directives of FERC Order No. 794:

1. **Evaluation of the Use of the Linear Regression Method to Calculate Frequency Response:** The median provided a better quality of measure of BA frequency response measure (FRM) performance as benchmarked against the Interconnection frequency response measure (IFRM) for events in the 2017 operating year. NERC recommends that Reliability Standard BAL-003-1.1 should continue to use the median method to measure annual BA FRM performance under the current construct of the standard.
2. **Evaluation of the Availability of Resources for Applicable Entities to Meet the Frequency Response Obligation:** NERC concludes that an adequate availability of frequency responsive resources existed in the 2017 operating year for each BA to meet their frequency response obligation (FRO).

This report also discusses work being done through Standards and Stakeholder Committee activities in support of Frequency Response.

[1] *Frequency Response and Frequency Bias Setting Reliability Standard*, Order No. 794, 146 FERC ¶61,024 (2014).
[2] Order No. 794, p. 3.
[3] December 1, 2016 through November 30, 2017

Introduction

Frequency support is recognized as an essential reliability service. NERC *Reliability Standard BAL-003-1.1*[4] is intended to require sufficient frequency response from the BAs to maintain Interconnection frequency within predefined boundaries by arresting frequency deviations and supporting frequency until the frequency is restored to its scheduled value. Reliability Standard BAL-003-1.1 is intended to provide consistent methods for measuring frequency response and determining the frequency bias settings. The standard applies to all BAs or the FRSG, if the BA is a member of an FRSG.

NERC, in coordination with the REs, has established a target contingency protection criterion for each Interconnection called the IFRO. NERC manages the administrative procedure for annually assigning an FRO to each BA based on the allocation formula below that considers load and generation of the BA in relation to the Interconnection. All BAs in an Interconnection are allocated an FRO and are required to meet their obligation. This includes load-only and generation-only BAs regardless of size. In the event that a BA does not have resources within their footprint to meet their FRO, they may acquire frequency response from entities outside of their balancing area. This is also true of generation-only BAs when their resources may be off-line during BAL-003-1.1 frequency events. Load and generation data used to calculate FRO is sourced from the most recent FERC Form 714s filed by BAs, or from similar data requested by NERC when the BA is non-FERC jurisdictional.

$$FRO_{BA} = IFRO\ x\ \frac{Annual\ Gen_{BA} + Annual\ Load_{BA}}{Annual\ Gen_{Int} + Annual\ Load_{Int}}$$

Specifically, BAL-003-1.1 Requirement 1 reflects the connection between FROs and BA obligations and states:

> "Each Frequency Response Sharing Group (FRSG) or Balancing Authority that is not a member of a FRSG shall achieve an annual Frequency Response Measure (FRM) (as calculated and reported in accordance with Attachment A) that is equal to or more negative than its Frequency Response Obligation (FRO) to ensure that sufficient frequency response is provided by each FRSG or BA that is not a member of a FRSG to maintain Interconnection Frequency Response equal to or more negative than the Interconnection Frequency Response Obligation."

Each BA calculates its FRM 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" as calculated on FRS Form 2 for each event shown on FRS Form 1. The ERO selects events in FRS Form 1 by using the *Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard.*[5] The FRS forms for each Interconnection are posted on the NERC Balancing Authority Submittal Site (BASS). The BASS is a secure website where BA users are vetted by NERC and granted access to obtain BAL-003-1.1 forms and information and to submit their annual performance results in accordance with the standard. NERC validates the submitted data that is also used to calculate annual frequency bias settings (FBS). The SEFRD for a typical BA in an Interconnection with more than one BA is basically the change in its net actual interchange on its tie lines with its adjacent BAs divided by the change in Interconnection frequency.[6] Assuming data entry is correct, FRS Form 1 is intended to automatically calculate the BA's FRM for the operating year as the median of the SEFRD values.

[4] https://www.nerc.com/pa/Stand/Reliability%20Standards/BAL-003-1.1.pdf

[5] https://www.nerc.com/comm/OC/BAL0031_Supporting_Documents_2017_DL/Procedure_Clean_20121130.pdf

[6] Certain adjustments to the SEFRD calculation are allowed and are incorporated into the FRS Form 1 and 2 functionality. They include adjustments for Contingent BA, Non-Conforming Loads, Pumped Hydro, Dynamic Schedules, and Transferred Frequency Response between BAs. All events listed on FRS Form 1 must be included in the annual submission of FRS Forms 1 and 2.

Chapter 1: Order 794 Directives

Analysis of Regression versus Median Statistical Method

The Commission directed NERC to "assess the accuracy of the linear regression methodology compared to the median methodology for purposes of determining Frequency Response Measure."[7] As stated in the Order:

> "… the Commission acknowledges NERC's commitment to studying the use of linear regression and the analysis contained in the Frequency Response Initiative Report, and directs NERC to continue its evaluation of the use of the linear regression methodology based upon experience and data collected following the implementation of BAL-003-1 and to submit a report to the Commission within three months after two years of operating experience once Requirement R1 of BAL-003-1 becomes effective (i.e., 27 months from the effective date of Requirement R1). The report should assess the accuracy of the linear regression methodology compared to the median methodology for purposes of determining Frequency Response Measure.[8]"

This report documents NERC's evaluation of the median versus regression method to determine BA FRMs based on the data collected following the implementation of BAL-003-1.1. Based on its analysis, NERC concludes that the median method provides a better quality of measure of BA FRM performance than linear regression. BAL-003-1.1 should continue to use the median to measure annual BA FRM performance under the current construct of the standard.

The median method provided a better quality of measure of BA FRM performance in the EI, WI, and TI as benchmarked against the IFRM for events in the 2017 operating year. BAL-003-1.1 should continue to utilize the median to measure annual BA FRM performance under the current construct of the standard.

The analysis herein uses BAL-003-1.1 frequency event data submitted by BAs in the EI and WI multi-BA Interconnections and the single-BA TI for the 2017 operating year. The 2017 operating year was the first year in which BAL-003-1.1 Requirement 1 was in effect for compliance purposes. BA performance data was submitted in years prior to the 2017 operating year under the BAL-003-1.1 field trial.

The premise of this analysis is that the calculation of frequency response performance at the interconnection level is the most accurate for any single BAL-003-1.1 event since it does not include variables, such as tie line error, metering error, and losses that may be seen at the BA level. The Interconnection frequency response performance measure ($IFRM_{A-B}$) calculates the ratio of the resource or load megawatt (MW) loss that initiated the event to the difference of predisturbance frequency (Value A) and the stabilizing period frequency (Value B). Value A and Value B are average frequencies from t_{-16} to t_{-2} and t_{+20} to t_{+52}, respectively, as defined in BAL-003-1.1. The MW loss experienced by the Interconnection that initiated the event must be determined in order to calculate $IFRM_{A-B}$ frequency response performance. Below is the equation for calculating $IFRM_{A-B}$.

$$IFRM_{A-B} = \frac{MW\ Loss}{10 * \Delta f_{A-B}}$$

Where:

MW Loss = Resource or Load Output immediately prior to the start of the event

f_{A-B} = Change in frequency from Value A to Value B

[7] Order No. 794, at P 34.

[8] *Id.*

This analysis compared the IFRM for each BAL-003-1.1 frequency event in the 2017 operating year to the aggregate performance for all BAs in the Interconnection for the same event. NERC analyzed BAL-003-1.1 events in EI, WI, and TI. The following reflects the analysis method:

- For analysis of the regression method the IFRM was plotted on the X-axis and the aggregated BA FRM performance is plotted on the Y-axis. The slope of the linear regression was calculated with the Y-intercept set to zero.
- For analysis of the median method the aggregated BA FRM performance was normalized for each event by dividing it by the IFRM for that event. The median of all aggregated BA FRM normalized events was then calculated.
- The results of the regression and median analyses are compared where the method that produces the outcome closest to 1.0 is considered to provide a better quality of measure as benchmarked against the IFRM.

The analyses of BAL-003-1.1 frequency events for the EI, WI, and TI produced consistent results as shown in **Table 1.1**. The median method produced the results closest to 1.0 for all three Interconnections using the aforementioned approach, suggesting that it produces a better quality of measurement than regression. The data that supports the aforementioned analysis and conclusion can be found in **Appendix A** of this report.

Table 1.1: Median versus Regression Analysis

Interconnection	Median	Regression	Preferred Method
Eastern	0.9784	0.9599	Median
Western	1.0138	1.0512	Median
Texas	0.9926	0.9895	Median

Conclusion

The median method provided a better quality of measure of BA FRM performance in the EI, WI, and TI as benchmarked against the IFRM for frequency events in the 2017 operating year. BAL-003-1.1 should continue to utilize the median to measure annual BA FRM performance under the current construct of the standard.

Availability of Frequency Response Resources

FERC Order No. 794 directed NERC to submit an evaluation of "the availability of resources for applicable entities to meet the Frequency Response Obligation."[9] The Commission "direct[ed] NERC to submit a report that provides an analysis of the availability of resources for each balancing authority and Frequency Response Sharing Group to meet its Frequency Response Obligation during the first year of implementation."[10] Based on its analysis, NERC concludes that an adequate availability of frequency responsive resources existed in the 2017 operating year for each BA to meet their FROs.

Adequate frequency responsive resources were available during the first year of BAL-003-1.1 implementation for BAs to meet their FROs.

The analysis herein used BAL-003-1.1 frequency event data submitted by BAs for the 2017 operating year and BA FERC Form 714 load and generation data for the 2016 reporting year. The analysis focused on the 34 BAs in the EI and 38 BAs in the WI and evaluated the individual BA FRM compared to their FRO in 2017 under BAL-003-1.1. In addition, FERC Form 714 data was used to assess whether a BA's percentage of total Interconnection generation (MWh) was less than their percentage of the total IFRO. The FRM performance

[9] Order No. 794, at P 3.
[10] Order No. 794, at P 60.

of the single-BA TI exceeded its FRO throughout the 2017 operating year and as such was not pertinent to this analysis.

In the EI, there were only two BAs whose FRM performance did not meet their FRO. Both are small BAs with combined FROs of less than 0.1 percent of the total IFRO. Only one of these BAs had a percentage of interconnection generation that was less than their percentage of IFRO. Further, neither of these two BAs used the transfer of frequency response from other BAs in the Interconnection to meet their FRO. As a result, these two BAs appeared to be outliers, and their performance issue did not indicate an elevated reliability risk to the BPS or lack of available frequency response resources in their Interconnection. Fifteen of the 34 BAs in the EI had a smaller percentage of Interconnection generation than their percentage of IFRO as reported on FERC Form 714 for the 2016 reporting year. Of these 15 BAs, only one BA had an FRM performance that did not meet their FRO. None of the BAs in the EI used the transfer of frequency response for any events in the 2017 operating year.

In the WI, there were no BAs whose FRM performance did not meet their FRO. Twenty of the 38 BAs in the WI had a smaller percentage of Interconnection generation than their percentage of IFRO as reported on FERC Form 714s for the 2016 reporting year. Of these 20 BAs, none had an FRM performance that did not meet their FRO as previously noted. Eleven of the BAs in the WI used the transfer of frequency response for at least one event in the 2017 operating year. In the 2018 operating year the total WI FBS increased nearly 14 percent from the previous year. This is because increased frequency response performance for BAL-003-1.1 resulted in more BAs using a FBS between 100 percent and 125 percent of their previous operating year's FRM (in accordance with the standard) in lieu of a FBS based on the Interconnection minimum. The data that supports the aforementioned analysis and conclusion can be found in **Appendix A** of this report.

Conclusion

NERC concludes that adequate frequency responsive resources were available during the first year of BAL-003-1.1 implementation for all BAs to meet their FROs. This is also true for BAs whose percentage of Interconnection generation was less than their percentage of IFRO. The results of this analysis are only applicable for the historic 2017 operating year and may not be representative of future years where changes in the resource mix, increases in inverter-based resource penetration, and increasingly diverse dispatch patterns may occur. These issues, including the issue of availability versus capability are discussed further in this report.

Chapter 2: BAL-003-1.1 Standard Authorization Requests

NERC received two standards authorization requests (SARs) proposing modifications to *Reliability Standard BAL-003-1.1*. The first SAR[11] was submitted by the NERC Resources Subcommittee (RS) and was posted for industry comment from June 19, 2017, through July 18, 2017. The second SAR[12] was submitted by the Northwest FRSG and was posted for industry comment from November 2, 2017 through December 1, 2017. This SAR proposes a two-phase approach to modifying the current standard.

The recommendations detailed in this report provide technical support for the scope defined in the consolidated SAR.

In addition, several issues highlighted in these two SARs were anticipated and raised in more detail in the NERC *2016 Frequency Response Annual Analysis* (FRAA), which was accepted by the RS on August 25, 2016, and by the NERC Operating Committee on September 30, 2016, and filed with the Commission on October 21, 2016. The SARs and FRAA reflect better understanding of frequency response calculations (including calculation of IFRO) now that Reliability Standard BAL-003-1.1 has been implemented. Several of these lessons learned and findings are referenced above. Now that the data is available for analysis, minor errors in assumptions as well as process inefficiencies have been identified in the standard and its supporting documents. It was anticipated that as frequency response improves, the approaches embedded in the standard for annual samples may need to be modified.

Based on comments received from the postings, the NERC RS SAR and the Northwest FRSG SAR have been consolidated by the SAR drafting team to create a new SAR (the consolidated SAR). Phase I of the consolidated SAR proposes revisions to BAL-003-1.1 and process documents to address the following:

- The inconsistencies in calculation of IFROs due to Interconnection frequency response performance changes of Point C and/or Value B
- The Interconnection resource contingency protection criteria
- The frequency nadir point limitations (currently limited to t0 to t+12)
- Clarification of language in Attachment A (i.e., related to FRSG and the time line for frequency response and frequency bias setting activities)
- Enhancement of BAL-003-1 FRS Forms (including the ability to collect and submit FRSG performance data)
- Removal of administrative processes from Attachment A to an ERO approved reference document

The scope of the work identified in the second phase, Phase II of the Consolidated SAR, proposes that the standard drafting team (SDT) evaluate modifications to BAL-003-1.1 to do the following:

- Establish a real-time Reliability Standard addressing the necessary frequency response to maintain reliability.
- Establish comparability for the appropriate responsible entities.
- Develop real-time measurements incorporating topology difference.
- Eliminate the incorrect indicators.

The SDT is now pursuing the objectives laid out in the consolidated SAR.

[11] https://www.nerc.com/pa/Stand/Project201701ModificationstoBAL00311/2017-01_SAR_June_2017.pdf
[12] https://www.nerc.com/pa/Stand/Project201701ModificationstoBAL00311/2017-01_SAR_NWPP_Nov2017.pdf

Appendix A: Supporting Data

Regression versus Median Statistical Method Analysis—Eastern Interconnection

Table A.1: EI Statistical Method Analysis

EI Event 2017 OY	Measured IFRM Abs (MW/0.1Hz)	Aggregated BAL-003-1.1 BA FRM Abs (MW/0.1Hz)	Aggregated BA FRM Normalized by IFRM		
31-Dec-16	2,615	2,667	1.0199	MEDIAN	0.9784
10-Jan-17	2,819	2,322	0.8237	REGRESSION	0.9599
12-Jan-17	3,125	2,281	0.7299		
26-Jan-17	2,335	2,587	1.1077		
28-Jan-17	1,637	2,239	1.3677		
14-Feb-17	2,736	2,776	1.0145		
22-Feb-17	2,692	2,697	1.0019		
25-Feb-17	1,269	1,222	0.9634		
7-Mar-17	2,088	2,007	0.9615		
20-Mar-17	3,194	3,212	1.0056		
8-Apr-17	1,660	1,578	0.9506		
11-Apr-17	1,889	2,453	1.2987		
26-Apr-17	1,645	1,223	0.7434		
18-May-17	1,398	1,339	0.9576		
22-May-17	2,920	2,351	0.8053		
8-Jun-17	2,208	2,718	1.2310		
19-Jun-17	2,143	2,539	1.1849		
24-Jun-17	2,548	2,170	0.8518		
17-Jul-17	3,133	3,019	0.9635		
21-Jul-17	3,863	2,661	0.6890		
27-Aug-17	2,540	2,429	0.9562		
28-Aug-17	2,173	2,163	0.9951		
2-Sep-17	2,317	2,365	1.0208		
8-Oct-17	1,369	2,344	1.7124		
26-Oct-17	1,683	1,456	0.8648		
7-Nov-17	1,625	1,222	0.7517		
7-Nov-17	2,286	2,236	0.9784		
8-Nov-17	2,473	2,794	1.1301		
20-Nov-17	1,813	2,128	1.1739		

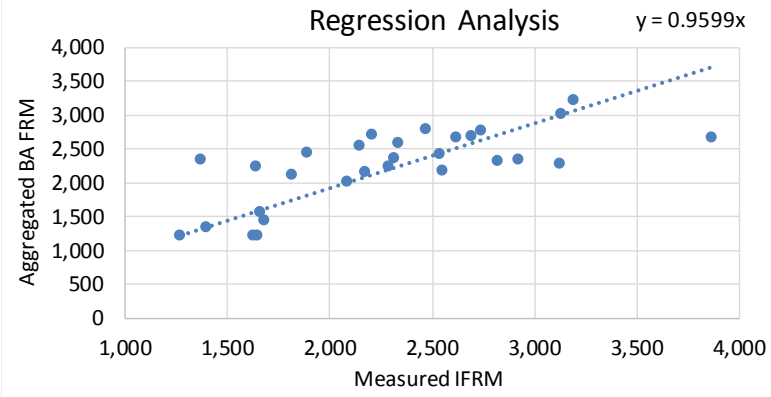


Figure A.1: EI Regression Analysis

Regression versus Median Statistical Method Analysis—Western Interconnection

Table A.2: WI Statistical Method Analysis

WI Event 2017 OY	Measured IFRM Abs (MW/0.1Hz)	Aggregated BAL-003-1.1 BA FRM Abs (MW/0.1Hz)	Aggregated BA FRM Normalized by IFRM		
19-Jan-17	2,536	1,532	0.60	MEDIAN	1.0138
20-Jan-17	1,838	1,670	0.91	REGRESSION	1.0512
24-Jan-17	2,676	2,932	1.10		
6-Feb-17	1,567	1,769	1.13		
6-Feb-17	1,382	1,371	0.99		
4-Mar-17	2,904	2,235	0.77		
8-Mar-17	1,722	1,947	1.13		
9-Mar-17	1,384	1,602	1.16		
17-Mar-17	1,691	1,420	0.84		
7-Apr-17	1,703	1,667	0.98		
14-Apr-17	1,250	1,234	0.99		
8-Jun-17	3,064	2,727	0.89		
15-Jun-17	1,215	1,170	0.96		
16-Jun-17	2,165	2,181	1.01		
19-Jun-17	1,728	2,385	1.38		
23-Jun-17	2,219	2,707	1.22		
4-Jul-17	1,358	1,540	1.13		
15-Jul-17	1,539	1,560	1.01		
29-Jul-17	2,158	2,233	1.03		
30-Jul-17	1,868	1,820	0.97		
8-Aug-17	1,527	1,763	1.15		
10-Sep-17	2,175	2,072	0.95		
15-Sep-17	2,286	3,033	1.33		
20-Sep-17	6,645	7,650	1.15		
24-Nov-17	1,709	2,082	1.22		

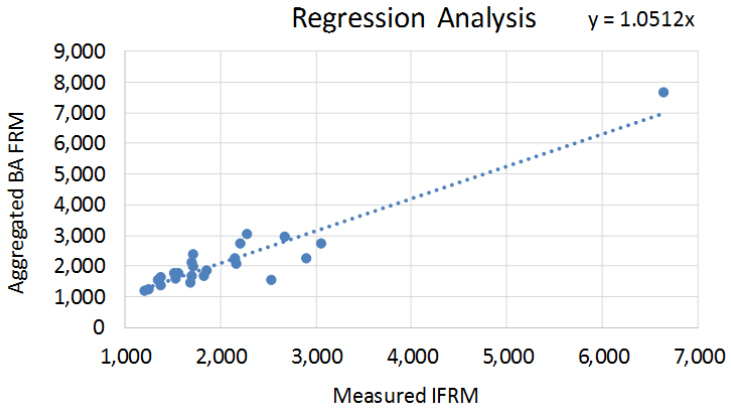


Figure A.2: WI Regression Analysis

Regression versus Median Statistical Method Analysis—Texas Interconnection

Table A.3: TI Statistical Method Analysis

TI Event 2017 OY	Measured IFRM Abs (MW/0.1Hz)	BAL-003-1.1 BA FRM Abs (MW/0.1Hz)	BAL-003 BA FRM Normalized by IFRM		
23-Dec-16	570	566	0.9931	MEDIAN	0.9926
7-Jan-17	840	843	1.0038	REGRESSION	0.9895
24-Jan-17	2,041	2,016	0.9877		
14-Feb-17	520	519	0.9981		
20-Feb-17	780	774	0.9926		
10-Mar-17	823	820	0.9965		
15-Mar-17	670	673	1.0045		
30-Mar-17	909	908	0.9991		
10-Apr-17	731	585	0.7999		
13-Apr-17	514	504	0.9811		
16-Apr-17	491	496	1.0095		
26-Apr-17	1,123	1,135	1.0109		
11-May-17	732	711	0.9709		
19-May-17	919	898	0.9779		
21-May-17	700	697	0.9961		
2-Jun-17	727	736	1.0115		
6-Jun-17	611	604	0.9895		
7-Jun-17	1,124	1,110	0.9880		
11-Jun-17	671	659	0.9816		
12-Jun-17	750	751	1.0008		
16-Jun-17	1,447	1,426	0.9853		
27-Jun-17	792	798	1.0074		
2-Jul-17	773	782	1.0113		
26-Jul-17	702	693	0.9868		
9-Aug-17	631	615	0.9752		
23-Aug-17	797	799	1.0019		
1-Sep-17	1,037	1,013	0.9762		
2-Sep-17	1,450	1,438	0.9917		
9-Sep-17	1,221	1,194	0.9781		
6-Oct-17	839	845	1.0066		
8-Oct-17	1,116	1,123	1.0059		
30-Oct-17	684	685	1.0009		
6-Nov-17	764	759	0.9936		
13-Nov-17	687	682	0.9921		
18-Nov-17	641	636	0.9923		
26-Nov-17	991	996	1.0049		

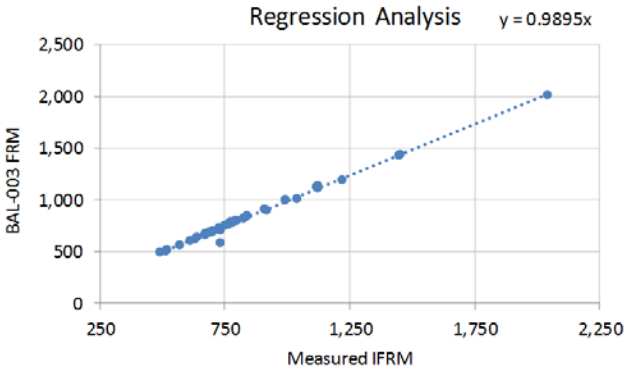


Figure A.3: TI Regression Analysis

Availability of Frequency Response Resources

BAs whose percentage of Interconnection generation was less than their percentage of IFRO as reflected on the FERC Form 714 submittals for the 2016 reporting year, are highlighted in red. See **Table A.4** and **Table A.5**.

Table A.4: EI Availability Analysis

2017 OY		Total $Gen_{BA}/TotalGen_{Int}$ Source: 2016 FERC 715
	FRM/FRO	% Int Generation - %IFRO
EI BA1	156%	-0.212%
EI BA2	230%	-0.007%
EI BA3	486%	0.090%
EI BA4	284%	-0.007%
EI BA5	-113%	-0.010%
EI BA6	406%	-0.019%
EI BA7	1105%	-0.010%
EI BA8	180%	0.169%
EI BA9	147%	-0.004%
EI BA10	125%	0.020%
EI BA11	546%	-0.642%
EI BA12	221%	0.181%
EI BA13	355%	-0.003%
EI BA14	290%	-0.315%
EI BA15	254%	-0.347%
EI BA16	297%	0.002%
EI BA17	217%	-0.006%
EI BA18	179%	0.255%
EI BA19	517%	0.158%
EI BA20	145%	0.291%
EI BA21	116%	0.014%
EI BA22	184%	0.032%
EI BA23	2296%	0.041%
EI BA24	168%	0.034%
EI BA25	265%	0.053%
EI BA26	412%	0.038%
EI BA27	142%	-0.012%
EI BA28	290%	0.040%
EI BA29	301%	-0.102%
EI BA30	-102%	0.030%
EI BA31	137%	0.154%
EI BA32	248%	-0.015%
EI BA33	500%	0.092%
EI BA34	170%	0%

Table A.5: WI Availability Analysis		
2017 OY		Total $Gen_{BA}/TotalGen_{Int}$ Source: 2016 FERC 715
	FRM/FRO	% Int Generation - % IFRO
WI BA1	317%	0.089%
WI BA2	192%	0.004%
WI BA3	307%	-0.058%
WI BA4	403%	-0.223%
WI BA5	257%	3.362%
WI BA6	161%	-3.461%
WI BA7	100%	-0.074%
WI BA8	202%	-0.262%
WI BA9	249%	0.102%
WI BA10	497%	0.414%
WI BA11	246%	0.036%
WI BA12	133%	-0.077%
WI BA13	103%	-0.121%
WI BA14	333%	-0.239%
WI BA15	100%	0.033%
WI BA16	270%	0.042%
WI BA17	235%	-0.297%
WI BA18	176%	0.197%
WI BA19	210%	0.003%
WI BA20	276%	-0.003%
WI BA21	189%	-0.086%
WI BA22	255%	-0.391%
WI BA23	120%	-0.244%
WI BA24	236%	0.037%
WI BA25	132%	0.254%
WI BA26	193%	0.234%
WI BA27	397%	0.053%
WI BA28	144%	-0.462%
WI BA29	287%	-0.070%
WI BA30	280%	-0.132%
WI BA31	280%	-0.007%
WI BA32	181%	-0.062%
WI BA33	283%	-0.040%
WI BA34	307%	0.840%
WI BA35	333%	-0.017%
WI BA36	156%	0.160%
WI BA37	213%	0.421%
WI BA38	220%	0.020%