UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Essential Reliability Services and the Evolving Bulk-Power System—Primary Frequency Response	**)** **)** **)**	**Docket No. RM16-6-000**

COMMENTS OF THE NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION IN RESPONSE TO NOTICE OF INQUIRY

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The North American Electric Reliability Corporation ("NERC") hereby provides comments on the Federal Energy Regulatory Commission ("Commission") Notice of Inquiry ("NOI") regarding whether to reform the Commission's rules and regulations to address primary frequency response.[1] The NOI "seeks comment on possible actions to ensure that the provision of primary frequency response continues to remain at levels adequate to maintain the reliability of the Bulk-Power System ["BPS"] in light of the ongoing transformation of the nation's generation resource mix."[2] Therefore, the NOI requests comments regarding: (i) whether the Commission should amend the *pro forma* Large Generator Interconnection Agreement and Small Generator Interconnection Agreement ("Interconnection Agreements") to require that new generation resources have frequency response capabilities; (ii) the performance of existing resources and whether to impose primary frequency response requirements on existing resources (in Reliability Standards, tariffs, or other formats); and (iii) whether to establish primary frequency response procurement and compensation rules. NERC appreciates the opportunity to respond on this essential reliability service and provides the following comments:

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[1] *Essential Reliability Services and Evolving Bulk-Power System–Primary Frequency Response*, 154 FERC ¶ 61,117 (2016) ("NOI").

[2] NOI, at P 37. *Id.*, at PP 15-20 (FERC relied, for example, on the Essential Reliability Services Task Force Measures Framework Report ("Framework Report") and Abstract Document ("Abstract") issued Dec. 17, 2015), NERC's State of Reliability Report for 2015, the NERC Operating Committee's recently approved *Reliability Guideline: Primary Frequency Control* ("OC Guidelines") issued Dec. 15, 2015, the NERC State of Reliability 2015 Report ("2015 SOR"), and NERC's 2015 Long Term Reliability Assessment ("2015 LTRA")).

I. EXECUTIVE SUMMARY

The NOI expresses the Commission's concern that the transforming resource mix may inadvertently cause a decline in available frequency response capability, exacerbated by the lack of nation-wide obligation that generator owners ("GOs") and generator operators ("GOPs") maintain generation resources that are ready to provide primary frequency response as needed to maintain frequency at 60 Hertz ("Hz"). The Commission states that, "a substantial body of evidence has emerged warranting consideration of possible actions to ensure that resources capable of providing primary frequency response are adequately maintained as the nation's resource mix continues to evolve."[3]

As discussed in the NOI, NERC has determined that frequency response is an essential reliability service, particularly during events, islanding, and system restoration. There must be adequate frequency response capability available to support reliability. Moreover, as recognized by the NOI, NERC's reliability assessments identify that the transforming resource mix may contribute to a future decline in available frequency response capability. NERC is completing additional analysis to confirm or refine this assessment. Although NERC is continuing to refine its understanding of these matters, NERC agrees with the Commission that currently available data demonstrates that additional measures could mitigate the risk of declining frequency response resources and ensure that sufficient frequency response capability is available and ready to respond to support reliability and system restoration. *See infra*, Section IV.A.

NERC has begun using a number of reliability tools focused on increasing the amount of frequency response available on the system while analysis continues and Reliability Standard BAL-003-1.1 is pending full implementation. BAL-003-1.1 requires balancing authorities

[3] NOI, at P 14.

("BAs") and frequency response sharing groups ("FRSGs") to ensure sufficient frequency response. NERC's recent additional activities include, for example, the NERC industry Advisory issued in early 2015, the NERC Operating Committee Reliability Guideline: Primary Frequency Control ("OC Guidelines") issued at the end of 2015, and certain Regional Entity requirements. NERC plans to continue developing approaches to support frequency response capability while frequency response studies mature in advance of the 2018 informational filing on Reliability Standard BAL-003-1.1. *See infra*, Section IV.B.

The NOI also requests comment regarding three sets of mandatory mechanisms to ensure sufficient frequency response capability is available to stabilize and maintain frequency within permissible limits. These three approaches include revisions to the *pro forma* Interconnection Agreements to impose frequency response capability requirements on new generation resources, requirements for existing generation resources, and market rules related to frequency response procurement and compensation. This multi-faceted approach is similar to current guidance, regional requirements, and market rules applicable in different areas of North America. NERC offers several factors for the Commission's consideration as it evaluates whether to pursue any or all of these mechanisms to ensure the availability of adequate frequency response capability.[4] *See infra*, Section IV.C.

II. COMMUNICATIONS

Notices and communications with respect to these comments may be addressed to the following:[5]

[4] NERC's frequency response analysis is continuing and Requirement R1 of Reliability Standard BAL-003-1.1 became effective on April 1, 2016. *See infra*, Sections III. and IV.B. and C.2. As a result, these comments do not advocate for enhancements to Reliability Standards or any specific solution, however, NERC reserves its right to provide comments in favor of any proposal for requirements to provide for reliable operation of the BPS.

[5] 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, to allow the inclusion of more than two persons on the service list in this proceeding.

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III. BACKGROUND

Primary frequency response is essential to reliable operation of the BPS. It is especially critical during events, islanding, and system restoration. Frequency response is the ability of a system or elements (such as generation resources) to respond to a change in system frequency.[6] Frequency response is the traditional metric used to describe how the interconnection has performed in arresting decline and stabilizing frequency after a loss of resources or load. Frequency response consists of synchronous inertial response ("SIR"), fast frequency response, primary frequency response, and supplemental slow responses. SIR is stored kinetic energy, extracted from the rotating mass of a synchronous machine following a disturbance on the power system. Its purpose is to maintain the minimum rate of change of frequency ("RoCoF"), as well as provide sufficient time for fast frequency response and primary frequency response to respond.[7] Primary frequency response is measured by relating the size of the resource lost to the resulting net change in system frequency. Primary frequency response arises from automatic

[6] NERC Glossary (explaining that Frequency Response is expressed as the sum of change in demand and generation, divided by the change in frequency, expressed in megawatts per 0.1 Hz (MW/0.1 Hz)).
[7] *See*, Framework Report, at p. 18.

generator governor response, load response, and other mechanisms.[8] As highlighted by the NOI, primary frequency response is key in the initial stages of frequency control and occurs in the first few seconds after a frequency event.

Reliability Standard BAL-003-1.1, Requirement R1, requires BAs and FRSGs to achieve an annual frequency response measure to meet their frequency response obligation ("FRO") in order to ensure sufficient frequency response performance in the interconnection. The interconnection frequency response obligation ("IFRO") is calculated on an annual basis to set a required level of response to ensure that frequency excursions caused by loss of large-scale resources do not cause load shedding by under-frequency load shedding ("UFLS") programs. Interconnection-level primary frequency response performance is measured against the IFRO to ensure adequate primary frequency controls. Requirement R1 became effective on April 1, 2016 and compliance begins December 1, 2016.

NERC Reliability Standards do not require GOs or GOPs to maintain frequency response capability, although GOPs must comply with reliability coordinator ("RC") directives that do not violate safety, equipment, regulatory, or statutory requirements,[9] and must provide frequency control data pursuant to Reliability Standard MOD-027-1.[10] Reliability Standard BAL-003-1.1 requires BAs and FRSGs to maintain sufficient frequency response in order to provide these entities with operational flexibility. When NERC filed its petition for approval of the BAL-003-1 standard, NERC's 2013 State of Reliability Report ("SOR") and the standard drafting team

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8 Such as automatic high-speed, frequency-based demand-side response.

9 *See*, Reliability Standard IRO-001-1.1, *Reliability Coordination — Responsibilities and Authorities*, Requirement R8 (effective through Mar. 31, 2017); *and* Reliability Standard IRO-001-4, *Reliability Coordination – Responsibilities*, Requirement R2 (effective Apr. 1, 2017).

10 *See*, Reliability Standard MOD-027-1, *Verification of Models and Data for Turbine/Governor and Load Control or Active Power/Frequency Control Functions*, Requirement 2 (providing, "Each Generator Owner shall provide, for each applicable unit, a verified turbine/governor and load control or active power/frequency control model, including documentation and data (as specified in Part 2.1) to its Transmission Planner in accordance with the periodicity specified in MOD-027 Attachment 1.").

demonstrated that there were, at that time, sufficient frequency response resources to support the FRO. NERC and stakeholder groups have continued to study this issue closely. In approving Reliability Standard BAL-003-1, Order No. 794 directed that within 27 months of implementation of the Reliability Standard (*i.e.*, by July 1, 2018), NERC must "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."[11] It is too soon to evaluate the impacts of Reliability Standard BAL-003-1.1. However, due to the importance of frequency response as an essential reliability service, the potential risks created by the transforming resource mix, and the Commission's directive for an informational filing, NERC has continued closely examining frequency response issues and sharing interim reports as the 2018 filing approaches.

IV. COMMENTS

NERC's analysis of the transforming electric power system demonstrates the need to ensure sufficient frequency response capability is available and ready to respond to the system, as needed. BAs and FRSGs must have enough frequency response capability available as called upon to support system restoration and reliable operation of the grid.

The NOI acknowledges that numerous NERC studies since the 2012 Frequency Response Initiative Report highlight the importance of frequency response and potential risks created by the transforming resource mix. When NERC submitted Reliability Standard BAL-003-1, the 2013 SOR and standard drafting team found that there were sufficient resources to support the FRO. While NERC must continue studying this issue to reach a definitive conclusion, data presently reveals the risk that frequency response capability may be declining. *See infra,* Section

[11] *Frequency Response and Frequency Bias Setting Reliability Standard*, Order No. 794, 146 FERC ¶ 61,024, at P 3 (2014).

IV.A. As a result, NERC is studying frequency response and working with stakeholders to develop guidance as research continues regarding whether there is a decline in frequency response capability and whether enhancements to Reliability Standards are necessary based on additional data. *See infra*, Section IV.B. The mechanisms discussed in the NOI would be consistent with NERC's findings regarding the need to ensure that adequate frequency response capability is available and ready to support reliability. Without advocating any specific mechanism, these comments identify various factors for the Commission's consideration as it evaluates next steps to preserve frequency response as an essential reliability service. *See infra*, Section IV.C.

A. Transformation of the Electric Power System Supports Additional Measures to Ensure Adequate Frequency Response Capability and Availability

Over the past few years, the North American electric power system has been transforming from a resource mix that heavily relies on coal and nuclear generation to one that integrates greater levels of natural gas, variable energy resources, distributed generation, and demand response resources. The increasing levels of asynchronous resources connected to the grid, coupled with retirement of conventional resources historically relied upon for frequency response, as a function of their large spinning generators and governor control settings, may cause a decline in frequency response resources. It will also cause a change in the dispatch of resources, resulting in various combinations of generation types and other resources across the daily and seasonal demand spectrum. As recognized in the NOI, NERC's studies show that this evolution in the resource mix may result in less SIR and primary frequency response. This potential decline could result in sharper and deeper frequency dips than currently observed, and contribute to greater likelihood of load shedding by UFLS programs.

Since the Commission approved Reliability Standard BAL-003-1, NERC has continued working on various projects to examine frequency response and prepare for the 2018 informational filing. NERC's SOR, for example, includes annual statistical analysis on past performance of frequency response trends, while NERC's Long-Term Reliability Assessment ("LTRA") examines future frequency response projections. Trends identified in the LTRA reflect NERC's concerns that the transforming resource mix may be contributing to a decline in frequency response resources. Recently, the 2015 LTRA noted that as conventional resources retire and asynchronous resources interconnect, NERC expects a more pronounced challenge to ensure sufficient frequency response. The 2015 LTRA stated that to understand changing dynamics, NERC must analyze current and future resource mix behaviors to determine the potential impacts of the retirement of 37 gigawatts of coal-fired and other fossil-fired generation expected by 2025.[12]

In addition, NERC has filed Frequency Response Annual Analysis reports ("FRAAs") in Docket No. RM13-11 for 2013, 2014, and 2015. The FRAAs examine frequency response in greater depth than the SORs and utilize a one-year look forward. NERC filed its latest FRAA in December 2015. The 2015 FRAA included, among its findings and recommendations, the IFROs for the coming year, recommendations that NERC continue adjusting frequency response calculations in the Eastern Interconnection for withdrawal of primary frequency response, and recommendations that NERC examine the use of gross megawatt ("MW") loss for generation when calculating IFROs.

[12] 2015 LTRA, at p. 10.

At the end of 2015, NERC also issued the Essential Reliability Services Task Force Framework Report ("Framework Report") and Abstract, which detailed how the transforming resource mix may impact the BPS. The Abstract explained:

> Recognizing that these changes represent a fundamental shift in the operational characteristics of the power system with potential reliability implications, a NERC task force assessed the impacts and identified measures to monitor continued grid reliability and resiliency. Generating resources need to be able to provide … frequency support… as Essential Reliability Services (ERSs) to balance and maintain the electric grid. Without these minimal characteristics, the grid could not be operated reliably.[13]

The Framework Report also highlighted measures that will lead NERC to better ascertain the risk of declining frequency response capability, in anticipation of additional mechanisms to ensure that sufficient frequency response resources are capable and available to respond as needed. For example, the Framework Report recommended measures to better monitor grid reliability and resiliency and identify trends. One key measure included a recommendation to evaluate primary frequency response at the interconnection level.[14] This proposal leveraged developments in higher resolution synchronized measurement technology that will permit better measurement of primary frequency response at the interconnection level and thereby provide more granularity than conventional evaluations of performance at the BA level. As discussed in Section IV.B below, NERC and stakeholders are implementing measures recommended in the Framework Report to perform a five-year, forward-looking frequency response assessment.[15]

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[13] Abstract, at p. 1; *and* Framework Report, at pp. iv-v.

[14] *See, e.g.*, Framework Report, at p. x (summarizing Measure 4 as, "[e]ach interconnection should measure the minimum frequency point (the Nadir) and all aspects of frequency response following observed contingency events (Measure 4).").

[15] *See e.g.*, Framework Report, at p. 7. The Essential Reliability Services Working Group is working to define and develop sufficiency guidelines for each measure identified in the Framework Report. *See*, Agenda – Operating Committee Meeting – March 8-9, 2016, at p. 3, *available at* http://www.nerc.com/comm/OC/AgendasHighlightsMinutes/OC_Agenda_Mar_8-9_2016_Final.pdf ("OC Meeting Agenda").

Therefore, NERC studies thus far have demonstrated that the transforming resource mix may be inadvertently decreasing the level of inertia and frequency response capability available in North America. NERC is continuing to analyze frequency response to better understand those risks and identify any appropriate recommendations or requirements to enhance frequency response. *See infra*, Section IV.B. As the January 2016 Reactive Power White Paper most recently summarized, "[w]ith a rapidly changing resource mix and bulk power system, ensuring frequency support is of utmost importance."[16]

B. Additional ERO Enterprise Measures and Continuing Studies to Support Frequency Response

While NERC continues to refine its analysis of frequency response in light of the transforming resource mix, the ERO Enterprise has been proactively pursuing measures to enhance frequency response capability and support BA and FRSG responsibilities to ensure sufficient frequency response.[17] The Commission refers to some of these activities in the NOI, and Sections III and IV.A above, describe the development of Reliability Standard BAL-003-1.1, followed by studies over the past few years.[18] NERC provides more details in this Section IV.B regarding (i) ERO Enterprise measures to support frequency response capability before the development of any mandatory nation-wide obligations that might supplement existing requirements, and (ii) a pending study to better ascertain the impacts of the transforming resource mix on frequency response with potential corrective measures. These practical activities demonstrate that the ERO Enterprise has been working with stakeholders to implement

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[16] *Comments of NERC in Response to NOPR on Reactive Power Requirements for Non-Synchronous Generation*, Docket No. RM16-1-000, at Attachment A, *NERC White Paper On FERC NOPR Proposal to Revise Standard Generator Interconnection Agreements*, at p. 3 (filed Jan. 27, 2016) ("Reactive Power White Paper").

[17] The ERO Enterprise is comprised of NERC and the eight Regional Entities: (i) Florida Reliability Coordinating Council, Inc.; (ii) Midwest Reliability Organization; (iii) Northeast Power Coordinating Council, Inc.; (iv) ReliabilityFirst Corporation; (v) SERC Reliability Corporation; (vi) Southwest Power Pool Regional Entity; (vii) Texas Reliability Entity, Inc. ("Texas RE"); and (viii) Western Electricity Coordinating Council ("WECC").

[18] *See e.g.*, NOI, at PP 19-20.

an approach to studying frequency response, frequently sharing the results of those activities with the public, recommending enhancements to frequency response, and implementing those recommendations while further analysis continues.

1. Frequency Response Guidance

In February 2015, NERC issued an industry advisory regarding governor response and control coordination for synchronous generation (the "Advisory").[19] In particular, the Advisory explained that the Eastern Interconnection Frequency Initiative identified that a significant portion of the Eastern Interconnection utilized generator dead bands or governor control settings that inhibit or prevent frequency response and identified the lack of more stringent regional requirements elsewhere. Therefore, NERC and stakeholders developed guidance applicable to all interconnections to set forth proper settings to facilitate primary frequency response in order to protect reliability of the BPS and system restoration. This guidance also benefited from meetings with turbine manufacturers regarding factory settings and equipment that support primary frequency response. The Advisory was intended to help generators provide better frequency response and improve accuracy of transmission planning models impacted by incorrect governor data. As noted in the NOI, NERC-led industry webinars and outreach also accompanied the Advisory.[20] The Advisory has already fostered greater understanding regarding frequency response and industry has improved frequency response capability in response to the Advisory. For example, PJM responded to the Advisory by revising PJM Manual 14D to add generator governor and distributed control system dead band and droop settings consistent with

[19] NERC Industry Advisory: Generator Governor Frequency Response (issued Feb. 5, 2015). *See also*, NOI, at PP 19 and 48 (discussing the NOI).

[20] NOI, at n. 88 (referencing a webinar on the Advisory).

the Advisory.[21] This now requires interconnection customers with PJM Interconnection Agreements to maintain settings consistent with the Advisory.

In December 2015, NERC also issued the OC Guidelines regarding governor response and disturbance control standard strategies. As acknowledged in the NOI, the OC Guidelines provide a coordinated operations strategy to assist BAs, FRSGs, GOs, and GOPs to provide sustained and effective primary frequency response to stabilize and maintain frequency within allowable limits, while maintaining acceptable frequency control.[22] The NOI requests comments regarding whether any frequency response requirements should incorporate the OC Guidelines.[23] Technical committees with the collective experience, expertise, and judgement of the electric industry developed the OC Guidelines. These OC Guidelines are accordingly, the most advanced set of nation-wide best practices and information currently available to support frequency response capability. As a result, the OC Guidelines could be materially beneficial in developing mechanisms to ensure sufficient frequency response capability.

At the same time, NERC takes this opportunity to highlight that the OC Guidelines are continuing to evolve, based on recommendations in the 2012 Frequency Response Initiative ("FRI") report.[24] For example, the OC Guidelines do not presently apply to asynchronous resources. Therefore, NERC is working with industry to revise the OC Guidelines so that they also apply to asynchronous resources and better address the risk that increasing levels of asynchronous resources might decrease frequency response capability available to support BA

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21 *See*, PJM Manual 14D: Generator Operational Requirements, at p. 144 (effective Dec. 22, 2015) (stating with regard to the revision made on May 1, 2015 that, "Section 7.1.1, Generator Real-Power Control: Added generator governor and distributed control system dead band and droop setting requirements consistent with the February 5, 2015 NERC Advisory on Generator Governor Frequency Response.").

22 *See*, NOI, at P 52.

23 NOI, at PP 45 and 52.

24 2012 FRI report.

and FRSG obligations under Reliability Standard BAL-003-1.1.[25] NERC anticipates further modifications to the OC Guidelines or other recommendations as NERC continues evaluating frequency response.

2. Regional Requirements

Regional reliability requirements may also be informative as North America improves frequency response capability. Texas Reliability Entity ("Texas RE") and the Western Electricity Coordinating Council ("WECC") have developed such requirements for their respective interconnections, based on unique interconnection characteristics. NERC is evaluating how these requirements might improve frequency response capability if incorporated into nation-wide obligations.

Due to a changing resource mix that includes large levels of asynchronous resources in the Electric Reliability Council of Texas ("ERCOT") region, for example, Texas RE developed Reliability Standard BAL-001-TRE-1 (effective April 1, 2014) to require adequate frequency response capability and performance. This Regional Reliability Standard sets forth requirements applicable to BAs, GOs, and GOPs that are related to identifying frequency measurable events ("FMEs"), calculating the primary frequency response for each generation resource and interconnection minimum frequency response, monitoring actual frequency response of the interconnection, setting governor dead band and droop parameters, and providing primary frequency response performance requirements.[26] As noted in the NOI, this standard requires generating units connected to the transmission system to operate with the governor in service and

[25] OC Guidelines, at p. 3; OC Meeting Agenda, at p. 10; *and* OC Meeting Agenda Presentations, at p. 59, *available at* http://www.nerc.com/comm/OC/AgendasHighlightsMinutes/March_2016_OC_Meeting_Presentations.pdf ("OC Meeting Agenda Presentations").

[26] *See*, Regional Reliability Standard BAL-001-TRE-01.

responsive when needed.[27] NERC studies show that Texas RE's Regional Reliability Standard has been a material contributing factor helping to improve frequency response performance in ERCOT.[28]

WECC regional reliability criteria PRC-001-WECC-CRT-1.2 also facilitates primary frequency support in the Western Interconnection by requiring generation resources with a governor to maintain droop settings within a range of 3% to 5%.[29] These regional requirements in Texas RE and WECC are instructive when evaluating nation-wide mechanisms to improve frequency response capability and availability.

3. NERC's Forward-Looking Assessment of Frequency Response

In addition to these guidance materials and regional obligations, NERC is continuing to implement past recommendations to better ascertain risks to frequency response and potential means of improving frequency response capability and availability. In addition to the FRAAs, SORs, and LTRAs for example, NERC is conducting a forward-looking frequency response Assessment of the Eastern Interconnection ("Forward-Looking Assessment"), which implements Measures recommended in the Framework Report for evaluating frequency response performance with greater granularity.[30] This Forward-Looking Assessment will evaluate frequency response performance at the interconnection level using a system configuration that looks forward five years based on scenarios and sensitivities of the projected resource mix in 2021. These scenarios will incorporate policy issues, such as the Clean Power Plan ("CPP"),

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[27] NOI, at P 32.

[28] 2014 FRAA, at p. 6

[29] WECC Criterion – PRC-001-WECC-CRT-1.2, Governor Droop Setting, at WR1 (originally approved 2011 and last revised Jan. 28, 2016).

[30] *See*, Planning Committee Meeting March 8-9, 2016, Meeting Minutes, at pp. 2 and 14-17, *available at* http://www.nerc.com/comm/PC/Agenda%20Highlights%20and%20Minutes%202013/Draft%20Planning%20Committee%20Meeting%20Minutes%20-%20March%208-9,%202016%20(Louisville,%20KY).pdf ("PC Meeting Minutes").

greater renewable penetration in the grid, wind generator frequency response capabilities, Regional Entity developed modeling constraints and guidelines, and other study assumptions.

The Forward-Looking Assessment is intended to confirm the effect(s) on frequency response caused by replacing conventional generation with increasing levels of wind and solar generation, how future transformations in the resource mix will affect frequency response, and reliability considerations to accommodate the integration of additional asynchronous resources. By looking forward over five years, instead of the one year period applicable under the FRAAs associated with BAL-003-1.1, this assessment will materially improve NERC's understanding of how the transforming resource mix is impacting frequency response and any reliability requirements that might be needed to address those findings.

Over the past three months, NERC has been working with industry, stakeholder committees, and the National Renewable Energy Laboratory ("NREL") on the Forward-Looking Assessment and plans to complete a report based on the Forward-Looking Assessment by the end of 2016 or first quarter of 2017. This Forward-Looking Assessment and the remainder of NERC's ongoing studies of frequency response will then culminate in the 2018 informational filing on Reliability Standard BAL-003-1.1.

In addition to the Forward-Looking Assessment, NERC and the North American Generator Forum are exploring a workshop to explore frequency response issues further with the GOs and GOPs. Technical conferences could be beneficial to examining essential reliability services. NERC has also been working with the Institute of Electrical and Electronics Engineers ("IEEE") team to support IEEE's efforts to align revisions of IEEE Standard 1547 for distributed resources (referenced in the Small Generator Interconnection Procedures) with frequency response needs

for long-term reliability of the BPS.[31]

NERC will continue working with stakeholders to study frequency response and develop enhancements to frequency response capability. As discussed above, studies thus far have demonstrated that the risk of declining frequency response resources may necessitate additional measures to ensure frequency response capability is available and ready to respond to support system restoration and reliability. NERC is now focusing on confirming the extent to which the transforming resource mix may influence frequency response capability and potential reliability measures to address frequency response. NERC will continue to share the results of its analyses with the Commission and stakeholders, as these become available.

C. Factors for Consideration as the Commission Evaluates Mechanisms to Ensure Adequate Frequency Response

The NOI proposes a proactive and multi-faceted approach to ensure that there is adequate frequency response capability available and ready to respond as needed to stabilize and maintain frequency at 60 Hz. First, the Commission asks whether the *pro forma* Interconnection Agreements should require frequency response capability. Second, the Commission asks whether frequency response requirements should be imposed on existing generation resources. Third, the Commission asks whether additional market rules would support frequency response. These potential mechanisms for frequency response capability would add to the effectiveness of Reliability Standard BAL-003-1.1, Regional Reliability Standard BAL-001-TRE-1, WECC regional reliability criteria, the NERC Advisory, and the OC Guidelines, as well as the PJM and ISO-New England ("ISO-NE") Regional Transmission Organization/Independent System Operator ("RTO"/"ISO") rules cited in the NOI. Each mechanism suggested by the NOI could support frequency response capability, although NERC has insufficient data, at present, to

[31] PC Meeting Minutes, at p. 2; *and* OC Meeting Agenda Presentations, at p. 15.

determine whether enhancements to Reliability Standards are necessary. In this Section IV.C, NERC sets forth factors for the Commission's consideration as it evaluates the mechanisms discussed in the NOI.

1. Revisions to the *Pro Forma* Interconnection Agreements

The Commission asks whether it should amend the *pro forma* Large Generator Interconnection Agreement and Small Generator Interconnection Agreement to require that new generation resources have frequency response capabilities as a precondition for interconnection. The Commission's *pro forma* Interconnection Agreements do not presently require generators to provide primary frequency response.[32]

Mandating frequency response capability under the *pro forma* Interconnection Agreements would be consistent with NERC's determination that the rapidly changing resource mix may reduce the level of available frequency response capability and that additional measures may help ensure the availability of sufficient frequency response. One positive aspect of reform to the Interconnection Agreements is that it would result in measurable, clear, requirements applicable to all new resources in a fair and equitable manner. In addition, based on results under Regional Reliability Standard BAL-001-TRE-1, NERC anticipates that revisions to the Interconnection Agreements to impose frequency response capability obligations on new generators should lead to tighter control and frequency stability. Moreover, imposing frequency response capability obligations on all new generation could improve operator flexibility for system restoration and island capability, help ensure the availability of sufficient frequency response resources to meet BA and FRSG FROs, and alleviate intertie pick-ups.[33] This change

[32] NOI, at P 41.
[33] OC Meeting Agenda Presentations, at p. 63.

would also align with frequency response capability obligations being developed by the European Network of Transmission System Operators for Electricity and now under evaluation by the European Parliament and Council.[34]

However, it is also important to emphasize that frequency response capability, by itself, would not require a resource to respond if called upon to help a BA or FRSG meet the FRO. As a result, these comments have emphasized the importance of mechanisms to ensure that sufficient frequency response capability is *available and ready to respond at all times, regardless of the mix of resources in the dispatch.* Regional Reliability Standard BAL-001-TRE-1, for example, includes capability requirements to enhance frequency response. The NOI appears as though it may contemplate availability as an aspect of frequency response capability.[35] However, NERC highlights this important factor out of an abundance of caution. Any mechanism to ensure frequency response capability should also ensure that resources are ready to support system restoration and reliability.

2. Requirements for Existing Resources

The NOI also asks whether the Commission should impose primary frequency response requirements on existing generators and whether these obligations should take the form of modifications to Reliability Standards or transmission provider tariffs.[36] Requirements for existing resources may enhance frequency response for reliability purposes and would be consistent with NERC's analysis of potential frequency response needs under the evolving

[34] Network Code on Requirements for Grid Connection Applicable to all Generators (RfG), European Network of Transmission System Operators for Electricity (last status update posted Dec. 2015), *available at*, https://www.entsoe.eu/major-projects/network-code-development/requirements-for-generators/Pages/default.aspx (including the final draft, *available at* https://www.entsoe.eu/Documents/Network%20codes%20documents/NC%20RfG/draft_ec_networkCodesJune.pdf)

[35] *See*, NOI, at P 21 (asking, for example, "what, if any, actions the Commission should take to ensure that adequate frequency response is available…").

[36] NOI, at P 52.

resource mix. NERC is closely analyzing the need for development of additional steps to enhance frequency response capability.

As discussed in Section III above, Reliability Standard BAL-003-1.1 requires BAs and FRSGs to maintain sufficient frequency response for reliability. This requirement became effective on April 1, 2016 and compliance begins on December 1, 2016. Therefore, it is too soon to determine whether there are insufficient resources to support BA and FRSG obligations under the standard or whether there should be a continent-wide frequency response Reliability Standard applicable to GOs and GOPs.

In anticipation of the 2018 informational filing regarding the methodology to calculate frequency response and the availability of frequency response resources, NERC is performing several analyses examining these questions. *See supra*, Section IV.B. Based on the NOI and NERC's current essential reliability measures, there may also be changes that could influence NERC's evaluation of frequency response needs. By 2018, NERC will be able to determine whether NERC should work with stakeholders to develop further frequency response related enhancements to Reliability Standards.

Regional or RTO/ISO tariff requirements may also result in tailored rules to support frequency response needs. Currently, two Regional Entities and at least two RTOs/ISOs maintain frequency response requirements or criteria that help maintain frequency response. As mentioned in the NOI and summarized above in Section IV.B, Regional Reliability Standard BAL-001-TRE-1 requires generators to operate with the governor in-service and to be responsive to frequency when the unit is online, tempered by the operating conditions of the generator. In addition, WECC regional criteria requires generators in the Western Interconnection with a governor to maintain droop settings within a certain range. Moreover, as stated in the NOI, PJM

interconnection customers seeking new Interconnection Agreements for asynchronous resources must use enhanced inverters capable of providing primary frequency response.[37] PJM Manual 14D also requires generators to maintain frequency response capability.[38] Similarly, ISO-NE Operating Procedure No. 14 requires a functioning governor on generators of 10 MW or greater.[39]

NERC's assessment is that such interconnection-level or RTO/ISO-level requirements may improve frequency response capability and performance by targeting unique needs within the region. The ERCOT Interconnection, for example, has experienced significant improvement in frequency response performance after implementation of Regional Reliability Standard BAL-001-TRE-1. RTOs and ISOs may also be capable of developing rules to support frequency response obligations and refine opportunities provided under Order No. 819, permitting sales of frequency response service at market-based rates.[40]

However, regional and RTO/ISO rules do not create uniform frequency response requirements across North America. Certain areas of the United States, for example, do not operate under RTOs and ISOs. This could lead to inconsistent frequency response capability and response characteristics within each interconnection. Inconsistent frequency response capability and requirements, in turn, could conceal adequacy issues if BAs and FRSGs within one region become dependent on frequency response resources procured from BAs and FRSGs within other regions. These factors may increase risks to system stability due to unbalanced frequency response. Such results could inadvertently undermine reliability.[41] Therefore, to achieve just

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37 *See*, NOI, at P 34

38 PJM Manual 14D, at Section 7.1.1 and 5.2.2.

39 NOI, at P 33; *and ISO New England Operating Procedure No. 14 - Technical Requirements for Generators, Demand Resources, Asset Related Demands and Alternative Technology Regulation Resources*, at Section II(I).

40 *Third-Party Provision of Primary Frequency Response Service*, Order No. 819, 153 FERC ¶ 61,220 (2015).

41 OC Meeting Agenda Presentations, at p. 63.

and reasonable requirements preserving reliability of the BPS, the Commission should evaluate transferability of frequency response and potential stability impacts when considering frequency response requirements on existing resources.

3. Market Mechanisms for Procurement and Compensation

The NOI requests comments on "procurement and compensation mechanisms for primary frequency response, and whether these mechanisms will ensure that the resulting rates are just and reasonable."[42] NERC agrees that market mechanisms could help ensure sufficient frequency response capability. In addition to those factors discussed above in Section IV.C.2 regarding regional or RTO/ISO requirements, industry participants have indicated that variable energy resources provide primary frequency response by withholding capacity from the markets, which affects their interest in providing frequency response service. Industry participants have also indicated that it may cost more to retrofit some resources with frequency response capability in comparison to units brought online more recently or being constructed. Market rules might help address some of these financial considerations at issue when GOs and GOPs consider providing frequency response.[43]

V. CONCLUSION

NERC maintains that there must be adequate frequency response capability present in the evolving resource mix to ensure reliability and support system restoration upon loss of resources or load. As discussed above, NERC is continuing in-depth frequency response analyses to better ascertain the impacts of the evolving resource mix on frequency response and evaluate whether to develop frequency response requirements that would supplement Reliability Standard BAL-

[42] NOI, at P 54.

[43] As discussed in n. 4, these comments do not advocate for enhancements to Reliability Standards or any specific solution, however, NERC reserves its right to provide comments in favor of any proposal for requirements to provide for reliable operation of the BPS.

003-1.1. NERC will continue to publicly share the results of these studies and will submit an informational filing to the Commission by 2018, consistent with Order No. 794. Moreover, NERC will continue working with stakeholders across the ERO Enterprise to develop measures that closely monitor frequency response capability. NERC is encouraged by the North American improved understanding regarding the need for frequency response capability and looks forward to continuing to work with the Commission and stakeholders on approaches to preserve and enhance this essential reliability service.

Respectfully submitted,

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Date: April 25, 2016

CERTIFICATE OF SERVICE

I hereby certify that I have served a copy of the foregoing document upon all parties listed on the official service lists compiled by the Secretary in Docket No. RM16-6-000.

Dated at Washington, DC this 25th day of April, 2016.

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