UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Reliability Standards for Geomagnetic Disturbances	**)** **)**	**Docket Nos. RM12-22-000**

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

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The North American Electric Reliability Corporation ("NERC")[1] hereby provides these comments in response to the Federal Energy Regulatory Commission's ("FERC" or the "Commission") October 18, 2012, Notice of Proposed Rulemaking ("NOPR")[2] proposing to direct NERC to file for approval with the Commission Reliability Standards that address the risks posed by geomagnetic disturbances ("GMDs") to the reliable operation of the Bulk-Power System, in two stages. NERC supports the Commission's deference in the NOPR[3] to NERC's technical expertise.[4]

In the first stage, the Commission proposes to direct NERC to file, within 90 days of the effective date of a final rule in this proceeding, one or more Reliability Standards that require owners and operators of the Bulk-Power System to develop and implement operational

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[1] The Federal Energy Regulatory Commission certified NERC as the electric reliability organization ("ERO") in its order issued on July 20, 2006, in Docket No. RR06-1-000. *North American Electric Reliability Corporation*, 116 FERC ¶ 61,062 (2006).

[2] *Reliability Standards for Geomagnetic Disturbances*, 141 FERC ¶ 61,045 (2012)("NOPR").

[3] *See infra*. at p. 7-8.

[4] In early 2011, NERC formed the Geomagnetic Disturbance Task Force ("GMDTF") with the goal of reaching scientific consensus on risks and mitigation options for the US-Canadian Bulk Electric System from a large coronal mass ejection from the sun. In February 2012, the GMDTF issued a *Special Reliability Assessment Interim Report: Effects of Geomagnetic Disturbances on the Bulk Power System* ("NERC Interim GMD Report"). The NERC Interim GMD Report concluded that the most likely impact to the Bulk-Power System resulting from a low-probability strong GMD event and the corresponding GIC flows is voltage instability, caused by a significant loss of reactive power support and a simultaneous substantial increase in transformer reactive power demand. *Available at*: http://www.nerc.com/files/2012GMD.pdf. The GMDTF is currently working on addressing the four recommendations identified in the NERC Interim GMD Report. This work will require close coordination with the ongoing collaborative efforts of the Electric Power Research Institute along with governmental and private sector efforts.

procedures to mitigate the effects of GMDs consistent with the reliable operation of the Bulk-Power System. In the second stage, the Commission proposes to direct NERC to file, within six months of the effective date of a final rule in this proceeding, one or more Reliability Standards that require owners and operators of the Bulk-Power System to conduct initial and on-going assessments of the potential impact of GMDs on Bulk-Power System equipment and the Bulk-Power System as a whole. Based on those assessments, the Reliability Standards would require owners and operators to develop and implement a plan so that instability, uncontrolled separation, or cascading failures of the Bulk-Power System, caused by damage to critical or vulnerable Bulk-Power System equipment, or otherwise, will not occur as a result of a GMD.

I. EXECUTIVE SUMMARY

The North American Bulk-Power System was not specifically designed to withstand the effects of a severe solar storm, although it has demonstrated resiliency to those impacts. NERC does not minimize the potential for GMDs to impact the Bulk-Power System, as events, such as the 1989 event in Hydro-Québec, demonstrate that severe solar storms can challenge the Bulk-Power System. During a severe GMD event, geomagnetically-induced current ("GIC") flow in transformers (resulting in half-cycle saturation) can substantially increase absorption of reactive power, create harmonics, and, in some cases, cause transformer hot-spot heating, which could lead to loss of reactive power support causing voltage instability, relay misoperations and potential equipment loss-of-life or damage, respectively. As a high-impact, low-frequency event, GMDs pose a unique threat to Bulk-Power System reliability, and NERC is committed to working with stakeholders and the Commission to address these challenges consistent with its responsibilities as the ERO.

As the Commission noted in the NOPR, there is significant disagreement in the scientific and manufacturing communities regarding the most likely effects of a GMD event on the Bulk-Power System.[5] The science regarding the impacts of GMDs on electric power systems is still in the developmental stages and much remains to be learned about the unique threat GMD's pose to reliability. The amplitude of GMDs (and hence the peak electric fields) experienced by the power system is dependent on a number of factors, including where the geomagnetic storm is centered, the direction of the fields along with their polarity, geomagnetic latitude, and the geology (electrical conductivity of the ground). A "one-size fits all" approach to crafting GMD Reliability Standards would fail to recognize the role of locational differences. As Commissioner LaFleur has noted, the panelists at the FERC technical conference agreed that "there can be considerable differences in GMD exposure and impacts depending on geography, where you are in the earth, ground conditions, grid configuration, and equipment condition…"[6] The magnitude, frequency, and duration of GICs, as well as the geology, and transformer design and relative health, are key considerations in determining the amount of heating that will develop in the windings and structural parts of a transformer.[7] For these reasons, addressing the impacts of GMDs through Reliability Standards presents many challenges.

NERC Reliability Standards are technology-neutral and NERC submits that the final rule should remain neutral with respect to particular procedures and the use of any particular technology. The Commission states in the NOPR that in some instances "automatic blocking"

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[5] NOPR at P 5 ("the Oak Ridge Study assessed the effects of a "1-in-100 year" geomagnetic storm on the modern Bulk-Power System. The Oak Ridge Study simulation concluded that such an event could put a significant number of Bulk-Power System transformers at risk for failure or permanent damage…The NERC Interim GMD Report concluded, on the other hand, that the worst-case scenario is 'voltage instability and subsequent voltage collapse,' and cites as an example the 1989 Hydro-Québec blackout.")(internal citations omitted).

[6] Electric Infrastructure Security Summit III, London, May 14-15, 2012, The House of Parliament, United Kingdom at p. 25.

[7] *See* NERC Interim GMD Report at 85.

will be necessary.[8] NERC notes that where other means or methods (such as automatic protection or system reconfiguration) can be shown to mitigate the effects of GMD, the second stage Reliability Standards should not *require* dedicated blocking devices or other specific equipment. NERC encourages the Commission in the final rule to use product and technology-neutral terminology such as "GIC mitigation."

It may be several years before there is enough data available to verify that the measures employed are effective. More system and equipment monitoring and testing will be needed to arrive at definitive conclusions. As noted in the NERC Interim GMD Report, monitors are a key source of real-time information that can guide system operators in determining real-time response, while supporting the development of simulation models vital to represent impacts on existing and planned system configurations.[9] The monitors can also provide valuable historical records of previous storm activity that can be evaluated and factored into power system planning and analysis.

Finally, NERC urges the Commission in its final rule to distinguish between GMD and electromagnetic pulse ("EMP") events and to clarify that issues related to EMPs are outside the scope of the final rule. There are significant differences between GMDs and EMPs, in both the nature of the threat, the science behind their impacts, and the scale and form of potential solutions. The distinction in the final rule will help focus industry solutions on the risk posed by GMDs.

NERC supports the Commission's dedication to raising awareness in the industry of the possible impacts of GMD on the Bulk-Power System and is committed to working with

[8] NOPR at P 34.

[9] *See* NERC Interim GMD Report at 71.

stakeholders and the Commission to address these issues.[10] The implementation proposed for the completion of the Reliability Standards is aggressive, as the Commission acknowledges,[11] however, NERC is committed to meeting whatever implementation targets are established by the Commission in the final rule.

II. BACKGROUND

In June 2010, NERC identified that GMDs were a serious threat to the reliable operation of the Bulk-Power System and that this issue required significant staff and industry attention with close monitoring of progress. Since that time, NERC has spent a substantial amount of time and effort working with experts across the North American power industry, U.S. and Canadian government agencies, transformer manufacturers, and other vendors in developing scientifically sound and repeatable conclusions.

On April 30, 2012, the Commission conducted a technical conference in Docket No. AD12-13-000 to discuss the effects of GMDs on the reliable operation of the Bulk-Power System. The conference consisted of two panels. The first panel was established to identify and discuss discrepancies between two reports on the subject authored by the Oakridge National Laboratory and NERC, respectively. The second panel featured a more general discussion on what could be done to address Bulk-Power System susceptibility to GMDs, with a particular emphasis on vulnerabilities that were commonly identified in both studies. Following the technical conference, comments were submitted by a significant number of parties.

On October 18, 2012, the Commission issued the instant NOPR proposing to direct NERC to develop and submit new GMD standards in a two-stage process. The NOPR does not

[10] *See* NERC Interim GMD Report at 87, Recommendation NERC-3-3 ("Raise awareness in industry, regulators and policymakers, and government agencies, of GMD impacts on the bulk power system").

[11] NOPR at P 19.

propose specific requirements, but offers guidance regarding the assessment of the grid's vulnerability to GMDs. The NOPR solicited comments on all aspects of its proposal.

III. NOTICES AND COMMUNICATIONS

Notices and communications with respect to this filing may be addressed to:[12]

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IV. COMMENTS

NERC supports the Commission's exercise of its authority pursuant to Section 215(d)(5) in the NOPR and the due weight given to NERC's technical expertise with respect to the content of the proposed Reliability Standards. The NOPR explicitly does not propose to require NERC or owners or operators of the Bulk-Power System to adopt any particular operational procedures or a particular solution in the second stage Reliability Standards to address GMDs.[13] NERC submits that this approach is consistent with Section 215(d)(2) of the Federal Power Act and

[12] Persons to be included on the Commission's service list are indicated with an asterisk. NERC requests waiver of 18 C.F.R. § 385.203(b) to permit the inclusion of more than two people on the service list.

requests that the final rule remain neutral with respect to particular procedures and the use of any particular technology.

NERC offers the following comments on the NOPR for consideration: (1) With respect to the Commission's proposed directive to require NERC to provide periodic reports on the effectiveness of the operational procedures in mitigating the effects of GMD events, NERC respectfully submits that such reports should be submitted no more frequently than on an annual basis and that this reporting obligation should expire upon implementation of the second stage Reliability Standards; (2) NERC requests the Commission to use product- and technology-neutral terminology such as "GIC mitigation" in the final rule and to focus on what specific reliability goals are to be accomplished (*e.g.*, capability of withstanding a 1 in 100-year event), rather than on the specific activities to be performed; (3) NERC asks that the Commission recognize the current scientific limitations associated with the K-Index and continue, in the final rule, to allow NERC the flexibility required to address such challenges; and (4) NERC requests that the Commission distinguish GMDs from EMPs in the final rule and to clarify that issues related to EMPs are outside the scope of the final rule. Finally, given the deadlines proposed by the Commission, NERC encourages the Commission in the final rule to expressly permit Commission Staff to actively participate in the standards development process.[14]

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[13] *See* NOPR at P 17 ("we are not proposing specific requirements or otherwise pre-judging what the ERO may eventually submit"); NOPR at P 18 ("The Commission does not propose to require the ERO or owners and operators of the Bulk-Power System to adopt any particular operational procedures. Owners and operators of the Bulk-Power System are the most familiar with the equipment and system configurations."); NOPR at P 34 ("While we do not propose to require a particular solution in the second stage Reliability Standards to address GMDs, we expect that some assessments will demonstrate that automatic blocking is necessary in some instances."). *See also* NOPR at P 35 ("The Commission does not propose to direct the ERO to require a particular automatic blocking technology, where blocking is necessary.").

[14] It will be beneficial and more efficient for the Commission and its experts, both internal and external, to present any technical concerns within the existing framework of the Commission-approved process. The Office of Electric Reliability ("OER") was created by the Commission on September 20, 2007, to focus on the development and implementation of mandatory and enforceable Reliability Standards. *See Delegations to the Office of Electric Reliability*, Order No. 701, 121 FERC ¶ 61,066 (2007). NERC respectfully submits that OER should actively and formally participate in the development of Reliability Standards, including via written comments, and that such a

A. First Stage: Reliability Standards Requiring Operational Procedures

The NOPR proposes to direct NERC to develop and implement operational procedures to mitigate the effects of GMDs within ninety days of the effective date of a final rule in this proceeding.[15] As noted in the NERC Interim GMD report, NERC supports the development of operational procedures. Training and education programs on the nature of the threat will allow Bulk-Power System Operators to more rapidly identify areas for improvement and take actions when necessary. While the implementation plan proposed for the completion of the first stage Reliability Standards is aggressive, NERC is committed to meeting whatever implementation targets are established by the Commission.

The Commission proposes to require NERC to provide periodic reports assessing the effectiveness of the operational procedures in mitigating the effects of GMD events.[16] NERC notes that operators do not currently have a sufficient level of monitoring capability to distinguish the particular impact of individualized operational procedures on their overall systems. In addition, as the NOPR acknowledges, "[c]urrent GMD forecasting methods provide limited time for operators to react once a GMD warning is issued."[17] Many of the forecast methods do not provide sufficient certainty or geographic accuracy vital to ensure appropriate actions are taken commensurate with the potential impacts. NERC's ability to assess the effectiveness of operational procedures is constrained by the limitations associated with monitoring and forecasting of GMD events. Should the Commission deem periodic reports

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role is consistent with and fulfills the purpose of the formation of OER and specifically, the Division of Reliability Standards. An open and participatory dialogue between Commission Staff and NERC Staff and NERC Standard Drafting Teams is an essential element to the effective and efficient development of Reliability Standards. For these reasons, NERC encourages the Commission in the final rule to expressly permit Commission Staff to submit written comments within the standard development process. *See also*, John S. Moot, *A Modest Proposal for Reforms of the FERC's Reliability and Enforcement Programs*, 33 Energy L.J.475, 489-90 (2012).

[15] NOPR at P 19.

[16] NOPR at P 21 ("Following implementation, the Commission proposes to require NERC to provide periodic reports assessing the effectiveness of the operational procedures in mitigating the effects of GMD events.").

[17] NOPR at P 23 (internal citation omitted).

necessary as proposed in the NOPR, NERC respectfully submits that such reports should be submitted no more frequently than annually and that this reporting obligation should expire upon the implementation of any second stage Reliability Standards.[18]

1. Limitations of GMD Forecasting: The K-Index

The emergence of new forecasting capability is vital to improving early warning and understanding of potential GMD effects and will directly impact the development of operational procedures.[19] Warnings of impending geomagnetic storms allow operators of electric power systems to minimize disruptions by adjusting operations. The most familiar means of characterizing the severity of geomagnetic storms is the K-Index. Dating back to 1932, it is one of the oldest of geomagnetic storm classification indices. This index varies over a range from 0 (minimal or no geomagnetic disturbance) to 9 (highest class of geomagnetic disturbance) in threshold steps. It is an indicator of the average local geomagnetic activity over a three-hour period.

Application of the K-Index is wide and varied and includes potential impacts on communication systems and satellite operations. This index was derived in an era of paper charts used for recording geomagnetic disturbances at remote observatories and with minimal data communication capability. This approach allowed a simple numerical classification to be collected from multiple observatories to describe not only the local variation in the geomagnetic field but also to develop a global sense of the severity of the storms. The National Oceanic and

[18] NERC notes that in order to fulfill this reporting obligation, the time and expertise of technical staff devoted to GMD will be needed. Upon implementation, it is unlikely that distinguishing between (i) the effectiveness of the operational procedures and (ii) the effectiveness of the second stage Reliability Standards in relation to the mitigation of the effects of GMD events will be possible.

[19] As acknowledged by the Comments of Foundation for Resilient Societies submitted in Docket No. RM12-22-000 at 22-23 (December 24, 2012) "space weather forecasting is an infant science…there is no precise method of predicting damaging currents induced in power grids."

Atmospheric Administration and other agencies around the world primarily focus their geomagnetic storm forecast and alert products on the K-Index.

The design and use of the K-Index has limitations in its application. It is only a reliable indicator of less-severe geomagnetic disturbance levels and periods of very low changes in magnetic field over time ("dB/dt")[20] and essentially no GIC. Some of the limitations of the K-Index are summarized below:

- The index saturates at K9 which is a low threshold and is not able to indicate levels of severity and intensity that would be important to power system operators. Therefore it blurs intensity, does not provide directionality of the magnetic fields, and is unable to communicate the extremes of the storm environment.

- The index is only determined once in each 3 hour time block (*i.e.*, eight times per day). Therefore, it also blurs the time-specific details of impulsive disturbances which show fast changes in current intensity and does not provide sufficiently granular time information to power system operators.

- At U.S. latitudes, the K9 threshold is reached at only a minimum 500 nanoTeslas variation over a three hour window. This means for slow variations, the dB/dt could be as low as three nanoTeslas per minute, while for very fast and intense variations, the dB/dt could be very high. Therefore, the K9 intensity in terms of dB/dt is highly ambiguous.

- The K-Index also cannot be reverse engineered to derive dB/dt from prior storms. Therefore, it has limited forensic value to provide meaningful comparisons with older storms.

Given these limitations, NERC submits that basing operational procedures on the K-Index alone would be problematic because of the associated uncertainties and inaccuracies. The K-Index cannot be used as an automatic triggering event for specific required actions because operational procedures need flexibility to account for actual operating conditions and the ability to adjust accordingly. This approach is consistent with several existing GMD-related operational

[20] The ratio between the amount of change in amplitude of the magnetic field (dB) and the time it takes to make that change (dt).

procedures.[21] NERC requests that the Commission consider in the final rule the current scientific limitations associated with the K-Index, and the impact that the emergence of new forecasting ability will have on a going-forward basis and continue to allow NERC the flexibility required to meet such challenges.

2. "Initial Action" Vulnerability Assessment

The NOPR proposes to require NERC to conduct an "initial action" vulnerability assessment[22] of critical Bulk-Power System facilities simultaneously with the development and implementation of the first stage GMD Reliability Standards.[23] The need to develop a vulnerability assessment tool was identified in the NERC Interim GMD Report as an industry recommendation.[24] NERC agrees that this assessment is necessary to identify and classify the at-risk population of transformers, however NERC clarifies that this assessment will be conducted by asset owners as identified in the NERC Interim GMD Report.[25] Asset owners are the appropriate entities to conduct this evaluation as information for this assessment will include a detailed listing of transformers by: (i) construction (*e.g.*, core type, winding connection); (ii) age; (iii) power system connection (*e.g.*, transmission network, generating station); (iv) location (*i.e.*, latitude/longitude); (v) transformer health based on agreed upon parameters, and (vi) in-service transformers with existing GIC monitoring installed. Transformer information will be

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[21] *See e.g.*, Northeast Power Coordinating Council, Inc., Procedures for Solar Magnetic Disturbances Which Affect Electric Power Systems at Section 4.2, *available at* https://www.npcc.org/Standards/Procedures /c-15.pdf; *see also*, PJM Interconnection, L.L.C., Manual 13: Emergency Operations at 47, *available at* http://www.pjm.com/~/media/documents/manuals/m13.ashx.

[22] NOPR at P 22. NERC notes that the 90-day deadline applicable to the development of the first stage Reliability Standards does not apply to the completion of this assessment.

[23] The NOPR (at P 22) references that the NERC Severe Impact Resilience Task Force identified critical and priority loads in a report and proposes that the "Initial Actions" effort would include giving special attention to those Bulk-Power System facilities that provide service to critical and priority loads. However, NERC notes that the report's identification of the types of loads that could be considered "critical and priority loads" was in the context of avoiding including those loads in load shedding plans, and giving such loads a priority during restoration efforts, rather than protecting those loads from GMD.

[24] NERC Interim GMD Report at p. 89.

[25] *Id.*

used to identify portions of the system subject to potential voltage collapse and transformers that may be at risk for accelerated end-of-life. NERC has worked with the Electric Power Research Institute ("EPRI") to develop a vulnerability assessment tool that calculates expected GIC levels and has released this simulation tool in an open-source code.[26] However, this is only one component of developing a comprehensive understanding of the effects of a GMD on the Bulk-Power System -- power flow and/or transient stability analysis must be performed in addition to a detailed thermal analysis of the transformer fleet.[27]

B. Second Stage: Reliability Standards

The NOPR proposes to direct NERC to develop second stage Reliability Standards within six months of the effective date of a final rule to require owners and operators of the Bulk-Power System to conduct initial and on-going assessments of the potential impact of GMDs on Bulk-Power System equipment and on the Bulk-Power System as a whole and requests comment on the feasibility of this deadline.[28] Based on these assessments, the NOPR proposes that the Reliability Standards would require owners and operators to develop and implement a plan so that instability, uncontrolled separation, or cascading failure of the Bulk-Power System, caused by damage to critical or vulnerable Bulk-Power System equipment, will not occur as a result of a GMD.[29] While the implementation proposed for the completion of the second stage Reliability Standards is aggressive, NERC is committed to meeting whatever implementation targets are established by the Commission in the final rule.

The NOPR states that such second stage plans "cannot be limited to operational procedures or enhanced training alone," however, the NOPR also states that the plans are

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[26] *See* NERC, EPRI Release Open Source Code to Analyze Geomagnetically Induced Currents (April 25, 2012) available at: http://www.nerc.com/fileUploads/File/News/NERC_DOE_EPRI25APR12.pdf.

[27] *See infra*. at 15-16.

[28] NOPR at P 23.

[29] NOPR at P 25.

"subject to the needs identified in the assessments"[30] NERC requests clarification regarding the reconciliation of these two principles. If a reliability assessment were to determine that there is a minimal need to protect against the potential impact of a GMD based on factors such as the age, condition, technical specifications or location of specific equipment, or due to the specific configuration of a system and/or its geomagnetic latitude, NERC requests the Commission to clarify whether this would provide a basis for a determination that operational procedures alone are a sufficient form of mitigation.

1. GMD Vulnerability Assessments of the Bulk-Power System

NERC supports the Commission's proposed approach to requiring owners and operators of the Bulk-Power System to conduct vulnerability assessments to determine how critical or vulnerable Bulk-Power System components react to simulated GICs of varying intensities.[31] In particular, NERC appreciates the Commission's recognition of the need to include new information and new research on GMDs given that the science related to GMDs is still developing.

2. Automatic GIC Blocking for Critical or Vulnerable Bulk-Power System Components

The NOPR states that the Commission "expect[s] that some [vulnerability] assessments will demonstrate that automatic blocking is necessary in some instances."[32] While the Commission states that it is not directing NERC to require a particular automatic blocking technology,[33] NERC notes that the Commission's use of the terms "automatic GIC blocking" and "automatic blocking" could be viewed as inconsistent with this statement as these particular

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[30] NOPR at P 25.
[31] NOPR at P 27.
[32] NOPR at P 34.
[33] NOPR at P 35 ("The Commission does not propose to direct the ERO to require a particular automatic blocking technology, where blocking is necessary.").

terms connote specific products and potentially suggest that this is a preferred method to manage GICs.[34] For this reason, NERC encourages the Commission to use product and technology-neutral terms such as "GIC mitigation" in the final rule. NERC Reliability Standards are technology-neutral and NERC appreciates the Commission's support of this vital tenet, which is particularly important with respect to GMD, given that science in this field is still maturing.[35]

The NOPR supports the consideration by NERC of whether the reliability goals of the second stage proposed Reliability Standards can be achieved by a combination of automatic blocking measures.[36] NERC notes that where other means or methods (such as automatic protection or system reconfiguration) can be shown to effectively mitigate or eliminate the effects of GMD, the second stage Reliability Standards should not *require* dedicated blocking devices. Power system simulations are needed to probe responses to magnetic storms and other disruptions, as well as to test proposed mitigation measures including changes in system configuration. In order to determine the full impact of a GMD on the Bulk-Power System, power flow and/or transient stability analysis must be performed in addition to a detailed thermal analysis of the transformer fleet. The tools to perform such an analysis are just now becoming available. In addition, transformer thermal models for transformer response to GIC are just now being developed. These models will require comprehensive testing and validation to ensure they are representative and likely impacts are revealed. As the analysis and modeling tools are tested and begin to mature, they will provide a sound technical basis for identifying appropriate

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[34] *See* NERC Interim GMD Report at 73 ("The term 'GIC blocker' is sometimes used to describe a GIC reduction device or GIC Mitigation System.").

[35] As Commissioner Moeller has noted "the consequences of unusually severe solar disturbances are not completely understood --- because no event on the scale under consideration today has ever happened to the modern power grid…" *See* Statement of Commissioner Philip D. Moeller on Solar Disturbances to Earth's Geomagnetic Field in Docket No. AD12-13-000(April 30, 2012).

[36] NOPR at P 36 ("The use of automatic blocking devices, such as transmission line series capacitors and transformer neutral blocking, are possible measures.")(internal citation omitted).

mitigation measures to address GMD impacts. NERC requests that, in the final rule, the Commission focus on what specific reliability goals are to be accomplished (*e.g.*, capability of withstanding a 1 in 100-year event), rather than on the specific activities to be performed.

The Commission proposes in the NOPR that the Reliability Standards should include a means by which the ERO can verify that selected blocking measures are appropriate.[37] However, there is no significant operational history for NERC to rely upon with respect to the evaluation of blocking devices or measures. NERC notes that testing and means of verification will require widespread adoption of GMD measures and therefore, verification of such measures will need to be developed and refined over time, supported by industry experience. Until such time as the means for such verification are established, NERC requests that the Commission suggest, but not require, the inclusion of such means in the Reliability Standard.

C. The Commission Should Distinguish Geomagnetic Disturbances From Electomagnetic Pulses in the Final Rule

While the Commission does not confuse EMPs and GMDs in the NOPR, EMPs are frequently studied alongside, and confused with, GMDs and issues related to EMPs are conflated at times.[38] Both GMDs and EMPs are part of a class of risks called high-impact, low-frequency events. These events are characterized by their potential to impose very large adverse impacts on the electric power system (and other infrastructures in some cases), their infrequent nature, and

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[37] NOPR at P 35. ("The Commission proposes that the Reliability Standards should include a means by which the ERO can verify that selected blocking measures are appropriate.").

[38] *See e.g.*, Comments of Foundation for Resilient Societies submitted in Docket No. RM12-22-000 at 38-40 (December 24, 2012)(" the mitigation measures for man-made GMD and for solar-storm GMD are generally the same"); Comments of InfraGard submitted in Docket No. RM12-22-000 at 2-3 (December 21, 2012) ("I would also encourage the Commission to not only consider GMD impacts to the bulk power infrastructure, but, also, the similar impacts of manmade electromagnetic pulse and the combination of GMD, manmade EMP, cyber and physical attacks on the grid."); Comments of Foundation for Resilient Societies, George H. Baker, submitted in Docket No. AD12-13-000, Technical Conference for Geomagnetic Disturbances at 1(May 18, 2012)("I see striking parallels between the EMP and GMD protection issues and solutions."); Resolution of the New York State Legislature calling for Study and Preparation for Infrastructure Damage Resulting from Electromagnetic Pulses submitted in Docket No. AD12-13-000, Technical Conference on Geomagnetic Disturbances (July 23, 2012).

hence, the industry's limited experience mitigating them. For clarity, NERC urges the Commission to distinguish GMDs from EMPs in the final rule.

One reason for the confusion between GMDs and EMPs is that a component of an EMP, the E3 wave, is similar to a GMD in its effects; however, the E3 wave has a larger magnitude and shorter duration than a GMD, and it would occur after the grid has already been exposed to the other more intense components of an EMP, the E1 and E2 waves.[39] As with GMD, the E3 component can induce currents that couple to transmission lines and drive high-voltage transformers to saturation, potentially disrupting or damaging equipment of the electric power delivery system. There are significant differences between EMP and GMD in both the nature of the threat, the science behind their impacts, and the scale and form of potential solutions.[40]

The NOPR cites several EMP studies and notes at P 10 that "[t]he Oak Ridge National Laboratory issued the Oak Ridge Study on the effects of electromagnetic pulses on the Bulk-Power System in January 2010." NERC reemphasizes its concerns expressed at the GMD Technical Conference that the threats posed by GMD and EMP are distinct.[41] While the effects of GMD are primarily limited to reliability of the Bulk-Power System, the effects of an EMP are significantly more extensive, going across multiple industries and technologies. Given that any EMP is likely to be the result of an intentional, determined attack on the United States or its neighbors, the entities best suited to address vulnerabilities to an EMP attack are federal agencies

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[39] *See* Radasky, W.A., "High-Altitude Electromagnetic Pulse (HEMP): A Threat to Our Way of Life." Available at: http://www.todaysengineer.org/2007/Sep/HEMP.asp.

[40] *See* Statement of the North American Electric Reliability Corp. for the Subcommittee on Cybersecurity, Infrastructure Protection and Security Technologies Committee on Homeland Security, U.S. House of Representatives hearing on "The EMP Threat: Examining the Consequences" (September 12, 2012).

[41] *See Comments of the North American Electric Reliability Corp*., Technical Conference on Geomagnetic Disturbances on the Bulk-Power System at p. 6, Docket No. AD12-13-000 (May 21, 2012) ("While, at some level, the physical mechanisms of geomagnetic disturbances and electromagnetic pulses may be similar, it is an oversimplification of the science and statistics involved to equate random emanations from the sun interacting with the outer atmosphere with a direct attack of a nuclear weapon – the electro-magnetic characteristics, impacts and preventive system solutions to address these risks are very different.").

such as the Department of Defense, Department of Homeland Security, Central Intelligence Agency, and Federal Bureau of Investigation, or the Royal Canadian Mounted Police and not the civilian power industry. For these reasons, NERC urges the Commission in its final rule to distinguish between GMD and EMP events and to clarify that issues related to EMPs are outside the scope of the final rule.

V. CONCLUSION

NERC supports the Commission's dedication to raising awareness in the industry of the possible impacts of GMD on the Bulk-Power System and is committed to working with stakeholders and the Commission to address these issues. For the reasons stated above, NERC respectfully requests that the Commission accept these comments for consideration.

Respectfully submitted,

/s/ Stacey Tyrewala

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Dated: December 26, 2012

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 26th day of December, 2012.

/s/ Stacey Tyrewala

Stacey Tyrewala
Attorney for North American Electric Reliability Corporation