

**UNITED STATES OF AMERICA  
BEFORE THE  
FEDERAL ENERGY REGULATORY COMMISSION**

<b>Reliability Standards for Transmission System Planned Performance for Geomagnetic Disturbances</b>	) ) )	<b>Docket No. RM15-11-000</b>
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**COMMENTS OF THE EDISON ELECTRIC INSTITUTE, AMERICAN PUBLIC  
POWER ASSOCIATION, ELECTRICITY CONSUMERS RESOURCE COUNCIL, THE  
ELECTRIC POWER SUPPLY ASSOCIATION, LARGE PUBLIC POWER COUNCIL,  
AND THE NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION**

The Edison Electric Institute (“EEI”), American Public Power Association (“APPA”), the Electric Power Supply Association (“EPSA”), Electricity Consumers Resource Council (“ELCON”), Large Public Power Council (“LPPC”), and the National Rural Electric Cooperative Association (“NRECA”) on behalf of their respective members (collectively the “Trade Associations”), hereby respectfully submit these comments in response to the Notice of Proposed Rulemaking (“NOPR”) issued by the Federal Energy Regulatory Commission (“Commission” or “FERC”) on May 14, 2015, in the above-referenced docket.<sup>1</sup> The Commission proposes to approve Reliability Standard TPL-007-1 (Transmission System Planned Performance for Geomagnetic Disturbance Events) (the “Reliability Standard” or “TPL-007”) filed by the North American Electric Reliability Corporation (“NERC”) in response to Order No.

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<sup>1</sup> *Reliability Standard for Transmission System Planned Performance for Geomagnetic Disturbances*, Notice of Proposed Rulemaking, 151 FERC ¶ 61,134 (2015).

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EEI is the association that represents all U.S. investor-owned electric companies. Our members provide electricity for 220 million Americans, operate in all 50 states and the District of Columbia, and directly employ more than 500,000 workers. With more than \$85 billion in annual capital expenditures, the electric power industry is responsible for millions of jobs related to the delivery of power, including the construction of modified or new infrastructure. Reliable, affordable, and sustainable electricity powers the economy and enhances the lives of all Americans. EEI has 70 international electric companies as Affiliate Members, and 250 industry suppliers and related organizations as Associate Members. Organized in 1933, EEI provides public policy leadership, strategic business intelligence, and essential conferences and forums. In addition, its members include Generator Owners and Operators, Transmission Owners and Operators, Load-Serving Entities, and other entities that are subject to mandatory Reliability Standards developed and enforced by NERC.

APPA is the national service organization representing the interests of not-for-profit, state, municipal and other locally owned electric utilities throughout the United States. More than 2,000 public power systems provide over 15 percent of all kWh sales to ultimate customers, and do business in every state except Hawaii. APPA utility members' primary goal is providing customers in the communities they serve with reliable electric power and energy at the lowest reasonable cost, consistent with good environmental stewardship. This orientation aligns the interests of APPA-member electric utilities with the long-term interests of the residents and

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<sup>2</sup> *Reliability Standards for Geomagnetic Disturbances*, Order No. 779, 78 FR 30,747 (May 23, 2013), 143 FERC ¶ 61,147, *reh'g denied*, 144 FERC ¶ 61,113 (2013)

businesses in their communities. Collectively, public power systems serve over 48 million people. Approximately 282 public power utilities are subject to mandatory Reliability Standards developed and enforced by NERC.

EPSA is the national trade association representing leading competitive power suppliers, including generators and marketers. Competitive suppliers, which collectively account for 40 percent of the installed generating capacity in the United States, provide reliable and competitively priced electricity from environmentally responsible facilities serving power markets. The comments contained in this filing represent the position of EPSA as an organization, but not necessarily the views of any particular member with respect to any issue.

ELCON is the national association representing large industrial consumers of electricity. ELCON member companies produce a wide range of products from virtually every segment of the manufacturing community. ELCON members operate hundreds of major facilities and are consumers of electricity in the footprints of all organized markets and other regions throughout the United States. ELCON represents NERC-registered manufacturing facilities; but most ELCON members are not NERC-registered. Reliable electricity supply is essential to our members' operations, but not at any cost.

LPPC is an association of the 25 largest state-owned and municipal utilities in the nation and has moved separately to intervene in this proceeding. LPPC members are located throughout the nation. Accordingly, LPPC has a direct interest in this proceeding.

NRECA is the national service organization dedicated to representing the national interests of cooperative electric utilities and the consumers they serve. NRECA is the national service organization for more than 900 not-for-profit rural electric utilities that provide electric

energy to over 42 million people in 47 states or 12 percent of electric customers. Kilowatt-hour sales by rural electric cooperatives account for approximately 11 percent of all electric energy sold in the United States. NRECA members generate approximately 50 percent of the electric energy they sell and purchase the remaining 50 percent from non-NRECA members. The vast majority of NRECA members are not-for profit, consumer-owned cooperatives. NRECA's members also include 65 generation and transmission ("G&T") cooperatives, which generate and transmit power to 668 of the 838 distribution cooperatives. The G&Ts are owned by the distribution cooperatives they serve. Remaining distribution cooperatives receive power directly from other generation sources within the electric utility sector. Both distribution and G&T cooperatives were formed to provide reliable electric service to their owner-members at the lowest reasonable cost.

## **EXECUTIVE SUMMARY**

The Trade Associations support the NOPR's proposal to approve the proposed Reliability Standard, and its associated violation risk factors ("VRFs") and violation severity levels ("VSLs"), to include one definition in the NERC Glossary of Terms,<sup>3</sup> the proposed implementation plan, and effective dates. The NOPR correctly qualifies that, based on the information available at this time;<sup>4</sup> the provisions of the proposed Reliability Standard are just and reasonable and address the specific parameters for the Second Stage GMD Reliability Standard on geomagnetic disturbance ("GMD")<sup>5</sup> events, as set forth in Order No. 779. Given the current and evolving state of limited historical geomagnetic data and scientific understanding

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<sup>3</sup> NERC, Glossary of Term Used in NERC Reliability Standards (April 2015) ("NERC Glossary), *available at* [http://www.nerc.com/files/glossary\\_of\\_terms.pdf](http://www.nerc.com/files/glossary_of_terms.pdf)

<sup>4</sup> See NOPR at P 4.

<sup>5</sup> Order No. 779 at P 6.

of geomagnetic disturbances,<sup>6</sup> as well as the early stage of development of technology tools and their availability for both the study and mitigation of severe GMD events, the Trade Associations support the Commission proposal to approve the TPL-007 implementation plan as proposed by NERC. Moreover, the Trade Associations support NERC's comments in this proceeding that request the Commission to approve the proposed Reliability Standard as filed.

The Commission should approve TPL-007 as a reasonable approach to the potential reliability risks associated with GMD events and that the proposed Reliability Standard should ensure reliable operation of the Bulk Power System ("BPS") against the risks of cascading outages, uncontrolled separation, or instability caused by a severe solar storm. The NOPR correctly states that "when tested against an appropriate benchmark GMD event, compliance with the proposed Reliability Standard should provide adequate protection for an applicable entity's system to withstand a geomagnetic disturbance." See NOPR at P 5. In this regard, the Trade Associations especially acknowledge the dedication and hard work of the NERC Standards Drafting Team ("NERC SDT"), which consisted of widely recognized experts in the field of GMD events. The NERC SDT for this project should be commended for its open, thorough, and deliberative process, as well as careful consideration of the full range of technical issues and the various perspectives on those issues. Accordingly, the exhaustive record of the project filed in this docket shows a soundly reasoned set of technical conclusions that provide sufficient basis for the Commission to make a reasoned decision to approve the proposed Reliability Standard as just and reasonable.

The Commission should not adopt the NOPR proposal to modify the benchmark GMD

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<sup>6</sup> See NOPR at P 5.

event so it is not solely based on spatial averaging. The Trade Associations strongly believe that the NERC SDT correctly selected a spatially averaged benchmark GMD event that is consistent with other mandatory reliability planning standards designed to ensure the reliable operation of the BPS. The Trade Associations strongly support the application of geospatial averaging as the approach that most realistically harmonizes with existing processes for conducting system planning, and for informing corrective actions to mitigate reliability issues identified through these studies. Application of an unrealistic benchmark event could lead to unnecessary costs for customers, while yielding very little tangible benefit to reliability. The Trade Associations believe that the spatial averaging method will provide a realistic method for analyzing wide-area effects caused by a severe GMD event, thus resulting in potentially lower costs to customers. The Trade Associations also support the associated scaling factors for latitudinal and geoelectric field effects. Since the broad application of peak geoelectric fields to the study of potential GMD effects would be an unrealistic projection of GMD effects, the Trade Associations do not support the Commission proposal to direct NERC to modify TPL-007 to apply peak geoelectric fields across broad geographic regions in planning studies.

Instead of directing further modifications to the Standard, the Trade Associations strongly recommend that the Commission allow NERC to gather experience with TPL-007 implementation and ensure that NERC continue proactive technical study of the reliability consequences of severe space weather.<sup>7</sup> Such work would inform the Commission's approach to the issues going forward, including consideration of future modifications to TPL-007. This

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<sup>7</sup> The Trade Associations agree that the Commission and NERC's shared goals can best be achieved by allowing the NERC GMD Task Force to move forward in addressing new research and implementation insights through its international, collaborative partnerships as an alternative to the NOPR proposal for NERC to submit within six months of a final rule a formal work plan and informational filing schedule.

offers a reasonable path forward, especially in light of the state of GMD historical data and analyses. The Trade Associations also recommend that the Commission seek to remain informed on the state of technology development for various types of blocking devices designed to protect equipment against geomagnetically induced currents (“GICs”) in affected transformers and transmission lines. While this technology appears to be in early stages of development and is not ready for broad application, several EEI members have conducted pilot programs to study the technical and cost effectiveness of such emerging technology. In addition, the EPRI Sunburst program provides a strong technical forum for technical research and development for such equipment.

The Trade Associations also do not support the Commission’s proposal to require entities to conduct thermal impact assessments using two different benchmarks. The Trade Associations support the NERC SDT’s recommendation to use a single value based on the proposed spatially averaged benchmark. The Commission should not adopt the NOPR proposal to direct a modification of TPL-007 to require thermal assessments on transformers based on engineering judgment because such a directive would be highly subjective and difficult to enforce. Where planning studies performed under TPL-007 identify a reliability issue, companies with ownership or operational responsibilities will apply their corrective action plans to mitigate the issues, which the Trade Associations would expect to be appropriately tailored to the level of risk and operating experience within their region. Therefore, the Trade Associations encourage the Commission to avoid a prescriptive approach that would apply an unsupported benchmark that does not align with the known risks based on recorded historical events.

The Trade Associations agree that additional monitoring equipment, including both GIC monitors and magnetometers could benefit ongoing technical research and technical study.

However, the imposition of a mandatory Reliability Standard is not necessary or appropriate to mandate such investment. Although the Trade Associations do not support such a mandate, if the Commission decides to move forward with its proposal to revise the proposed Reliability Standard and to require the installation of monitoring devices, then the Commission should also direct NERC to consider the cost impacts of this directive. The cost of installing monitoring equipment as well as supporting communications (or leased data services) could be substantial, depending on the network identified by NERC, which could greatly impact ratepayers already paying for a multitude of other Reliability Standards compliance efforts.

The Trade Associations believe that extending existing programs of the U.S. Geological Survey provides the best way to address the expansion of the existing network of magnetometers within the United States. The Trade Associations would also support an expanded USGS partnership with the Geological Survey of Canada that operates the CANadian Magnetic Observatory System.<sup>8</sup> The Trade Associations note that many companies have installed GIC monitoring equipment and many others have plans to install additional monitors to meet their particular needs for GIC data and address their operational or planning needs.

If the Commission seeks to have NERC develop a plan for coordinating various data and research activities for GMD technical study, these comments offer some considerations to the Commission in shaping such a directive. The Trade Associations envision such activities as being embedded within registered entity corrective action plans.<sup>9</sup> Furthermore, to continue discussion and identify potential useful data gathering and analysis projects, both the NERC

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<sup>8</sup> <http://geomag.nrcan.gc.ca/obs/canmos-en.php>

<sup>9</sup> Corrective Action Plan: A list of actions and an associated timetable for implementation to remedy a specific problem: NERC Glossary of Terms; Date: May 19, 2015, at 26.

Operating Committee and Planning Committee should include in their meeting agendas explicit discussion on addressing the collection, open sharing and management of monitoring data, which could support the development of a broader NERC plan.

The Trade Associations agree that the Reliability Standard should have deadlines for corrective action plans but there should be a mechanism for case-by-case requests for extensions of time. The Trade Associations also strongly support the development of FERC policy ensuring cost recovery for the costs incurred to comply with TPL-007-1 as well as GIC monitors and magnetometers.

As a final matter, while the Trade Associations have no specific comments regarding the OMB cost estimate in the NOPR, the Trade Associations underscore that the potential implementation costs for TPL-007 cannot be known with confidence. To the extent that the Commission directs the examination of peak geoelectric fields as suggested in the proposed directives, the Trade Associations envision a very significant likelihood that implementation costs could become far higher than those shown in the NOPR.

## **BACKGROUND**

While strong GMD events are extremely rare, the Commission has found that their potential impact on the reliable operation of the BPS requires it to act under Section 215(d)(5) of the Federal Power Act (“FPA”). As a consequence, the Commission directed NERC to develop and submit for FERC-approval proposed Reliability Standards that address the impact of geomagnetic disturbances on the reliable operation of the BPS, and directed NERC to implement

this directive in two stages.<sup>10</sup>

In the first stage, FERC directed NERC to submit one or more Reliability Standards that require owners and operators of the BPS to develop and implement operational procedures to mitigate the effects of GMDs consistent with the reliable operation of the BPS.<sup>11</sup> In the second stage, the Commission directed NERC to submit one or more Reliability Standards that require owners and operators of the BPS to conduct initial and on-going assessments of the potential impact of the benchmark GMD events on BPS equipment and the BPS as a whole. The Commission also directed that second stage GMD Reliability Standards must identify benchmark GMD events that specify the severity of GMD events that a responsible entity must assess for potential impacts on the BPS and therefore develop a plan to protect against instability, uncontrolled separation, or cascading failure of the BPS, caused by damage to critical or vulnerable BPS equipment, or that may otherwise result from a benchmark GMD event.

On January 21, 2015, NERC requested Commission-approval for proposed Reliability Standard TPL-007-1 and its associated VRFs and VSLs, implementation plan, and effective dates. The proposed Reliability Standard TPL-007-1 establishes requirements for certain entities to assess the vulnerability of their transmission systems to GMDs.<sup>12</sup> In the proposed Reliability Standard, NERC set the benchmark event as a 1-in-100 year event. If an applicable entity

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<sup>10</sup> Order No. 779, 143 FERC ¶ 61,147, at P 1.

<sup>11</sup> Id.. NERC submitted Reliability Standard EOP-010-1 (Geomagnetic Disturbance Operations) in compliance with Order No. 779 corresponding to the First Stage GMD Reliability Standards, which FERC approved in *Reliability Standards for Geomagnetic Disturbance Operations*, Order No. 797, 79 FR 35,911 (June 25, 2014), 147 FERC ¶ 61,209, *reh'g denied*, Order No. 797-A, 149 FERC ¶ 61,027 (2014).

<sup>12</sup> This proposed standard requires responsible entities to maintain system models needed to complete GMD Vulnerability Assessments (Requirements R1 and R2), have criteria for acceptable system steady state voltage performance during a benchmark GMD event (Requirement R3), and complete a GMD Vulnerability Assessment once every 60 calendar months, based on the GMD event definition described in Attachment 1 of the proposed Reliability Standard (Requirement R4).

concludes based on the GMD Assessment that its system does not meet specified performance requirements, it must develop a corrective action plan that addresses how the performance requirements will be met (Requirement R7).

The Commission proposes to approve this standard as just, reasonable, not unduly discriminatory or preferential, and in the public interest pursuant to Section 215(d) of the FPA and consistent with the directives in Order No. 779. See NOPR at P 22. However, the Commission also proposes to direct NERC to develop modifications to the benchmark GMD event definition set forth in Attachment 1 of the Proposed Reliability Standard so that the definition is not based solely on spatially-averaged data. The Commission also proposes to direct NERC to submit a work plan, and subsequently one or more informational filings that address specific GMD-related research areas. NOPR at P 23.

The NOPR states that the Commission's primary concerns with the proposed Reliability Standard are related to the benchmark GMD event described in Attachment 1 of the proposed Reliability Standard, as well as the heavy reliance on spatial averaging. Thus, while proposing to approve the Proposed Reliability Standard, the NOPR also proposes to direct NERC to make several modifications intended to develop "a more complete set of data and a reasonable scientific and engineering approach." *Id.* at PP 5. The NOPR further proposes revisions to Requirement R7 of the proposed Reliability Standard to ensure that when an applicable entity identifies the need for a corrective plan, the entity acts in a timely manner.

## COMMENTS

### **I. The Commission should approve Reliability Standard TPL-007-1.**

Pursuant to Section 215(d) of the FPA, the Commission should approve the proposed Reliability Standard as just, reasonable, not unduly discriminatory or preferential, and in the public interest. See NOPR at P 22. The Trade Associations agree that the proposed Reliability Standard addresses the directives in Order No. 779 corresponding to the development of the Second Stage Reliability Standards. Id. The proposed Reliability Standard constitutes an important step in addressing risks posed by GMD event to the BPS. See NOPR at P 22.

The Trade Associations commend NERC and the NERC SDT for their clear and thoughtful attention to the Commission directive, noting the proposed Reliability Standard strikes an appropriate balance between maintaining reliable operations, which is mandatory, while allowing entities much needed flexibility to determine whether additional protections might be appropriate based on regional and company risk profiles. In addition, the Trade Associations ask the Commission to take note of, and give due weight to, the high level of education, knowledge and experience within the members of the NERC SDT regarding GMD events.

The Commission further proposes that NERC develop modifications to the Reliability Standard concerning: (1) the calculation of the reference peak geoelectric field amplitude component of the benchmark GMD event definition; (2) the collection of GIC monitoring and magnetometer data; and (3) deadlines for completing corrective action plans. NOPR at P 23. The Trade Associations will address each of these proposals below.

## **II. The Commission should not direct NERC to modify the benchmark GMD event at this time.**

The Trade Associations agree with the Commission that the benchmark GMD event definition proposed by NERC fully complies with the directives in Order No. 779 and the criteria set forth under FPA Section 215. See NOPR at P 32. However, the Trade Associations do not support further directives to develop modifications to the benchmark GMD event definition so that the definition is not based solely on spatially-averaged data. See NOPR at PP 31 and 33.

The Trade Associations share the Commission's concern for individual transformers; however, it is critical for the Commission to recognize that the purpose of any Reliability Standard is to ensure reliable operation, not the complete and total protection of each and every individual asset.<sup>13</sup> The Trade Associations note that within the statutory definition of "reliable operation," systems must withstand the "unanticipated failure of system elements" to protect against instability, uncontrolled separation, or cascading failures of the BPS.<sup>14</sup> Instead of revising the benchmark, the Commission should recognize the daunting challenge of shaping a mandatory requirement that recognizes the widely varying effects of a severe GMD event as well as the widely varying facts, circumstances, and configurations across the BPS. Furthermore, the Commission should recognize that special considerations for unique facilities identified in the planning studies or facilities that serve certain types of customers are best addressed in corrective action plans and that individual entities have similar concerns for the protection of their high

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<sup>13</sup> The NOPR acknowledges this in that it states that "when tested against an appropriate benchmark GMD event, compliance with the proposed Reliability Standard should provide adequate protection for an applicable entity's system to withstand a geomagnetic disturbance." See NOPR at P 5.

<sup>14</sup> FPA section 215(a)(4) states that: "The term 'reliable operation' means operating the elements of the bulk-power system within equipment and electric system thermal, voltage, and stability limits so that instability, uncontrolled separation, or cascading failures of such system will not occur as a result of a sudden disturbance, including a cybersecurity incident, or unanticipated failure of system elements."

value assets but such protections are better implemented through these plans.

For the reasons set forth in these comments, the Trade Associations believe that the NERC standard development process achieved the right balance between statutory responsibility for BPS reliability and individual owners' responsibilities for managing their assets, and therefore support the selection of spatial averaging for both the proposed benchmark and for use in Transformer Thermal Impact Assessments.

**A. Spatial-Averaging is an appropriate approach for defining a benchmark GMD event when analyzing wide area impacts and maintaining reliable operations.**

The Trade Associations support the use of spatial averaging for calculating the reference geoelectric field amplitude of 8 V/km for wide area impacts. While the Trade Associations acknowledge that the use of spatial averaging reduces the reference peak geo-electric field, such reductions are both necessary and appropriate for several reasons. First, the peak geo-electric field amplitude only affects relatively small areas and will quickly decline with distance from the peak field area. Second, the standard is intended to address wide-area effects since GMD events occurring on a wide scale are more likely to have broad impacts on BPS reliability, which the standard is designed to address. Third, the benchmark event is designed to provide a realistic estimate of wide-area effects caused by a severe GMD event, such as increased var absorption, voltage depressions and harmonics.

As suggested in the NOPR, the Commission also recognizes that the application of peak geoelectric field amplitudes across an entire planning area greatly distorts and exaggerates the true impacts of the GMD event. Taken together, the application of geospatial averaging most realistically harmonizes with the NOPR, that the geoelectric field values used to conduct GMD Vulnerability Assessments and thermal impact assessments should reflect the real-world impact

of a GMD event on the BPS and its components. See NOPR at P 21.

The Trade Associations further agree with the Commission that “imputing the highest peak geoelectric field value in a planning area to the entire planning area may incorrectly overestimate GMD impacts.” See NOPR at P 21. However, the Trade Associations disagree with the Commission’s assertion that solely using spatial averaging “would distort this complexity and could underestimate the contributions caused by damage to or misoperation of the BPS components to the system-wide impact of a GMD event.” NOPR at P 35. The work performed by the NERC SDT showed that GMD events must be addressed on a wide area. Without characterizing GMD on regional scales, statistical estimates could be weighted by local effect and suggest unduly pessimistic conditions when considering cascading failure and voltage collapse.<sup>15</sup>

It is important for the Commission to recognize that earlier geoelectric field amplitude statistics and extreme amplitude analyses were created from individual magnetometer stations; thus, these statistics reflect only localized spatial scales. Without characterization of GMD on regional scales, statistical estimates would be weighted by local effects and suggest unrealistic conditions for system analysis, causing studies to significantly overstate the potential effects of the benchmark event. Ultimately, application of an unrealistic benchmark event could lead to unnecessary costs for customers, while yielding very little tangible benefit to reliability. The Trade Associations believe that the spatial averaging method will provide a realistic method for analyzing wide-area effects caused by a severe GMD event, thus resulting in potentially lower costs to customers while ensuring reliable operation of the BPS.

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<sup>15</sup> NERC’s Benchmark GMD Description, December 5, 2014, at 9.

If the Commission remains concerned that peak geoelectric field amplitude values need to be for some future modification of the Standard, it should allow the proposed Reliability Standard to move forward as written using the spatial averaging method and allow NERC to further determine the appropriate localized studies to be performed by moving the “local hot spot” around a planning area. This approach may better ensure that the peak values only impact a local area instead of unrealistically projecting uniform peak values over a broad area. This approach also should better align with the Commission’s concerns because this type of study would more accurately reflect the real-world impact of a GMD event on the BPS. The Trade Associations understand that existing planning tools may not yet have such capabilities, but the tools can be modified to allow such study.

**B. The Trade Associations support the NERC SDT’s selection of a 500 km square for the development of the GMD Benchmark Event.**

In the NOPR, the Commission expressed concern that NERC had not made it clear “how the standard drafting team determined that spatial averaging should be performed using a square area 500 km in width.” See NOPR at P 34. To help to inform the Commission, the Trade Associations offer the article “Regional-scale high-latitude extreme geoelectric fields pertaining to geomagnetically induced currents”<sup>16</sup> as a sound explanation for the selection of a 500 km square for the development of the GMD Benchmark. The paper reflects the thought process used by the NERC SDT in its deliberations.

The 2015 GMD/GIC Scaling Paper supports the use of 100 km wide squares for the

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<sup>16</sup> <http://www.earth-planets-space.com/content/pdf/s40623-015-0255-6.pdf> See Antii Pulkkinen, Emanuel Bernabeu, Jan Eicher, Ari Viljanen, and Chiomezyo Ngwira, “Regional-scale high-latitude extreme geoelectric fields pertaining to geomagnetically induced currents,” *Earth, Planets and Space*, 2015, 67:93, DOI: 10.1186/s40623-015-0255-6; <http://www.earth-planets-space.com/content/67/1/93>; <http://www.earth-planets-space.com/content/pdf/s40623-015-0255-6.pdf> (“2015 GMD/GIC Scaling Paper”).

subsections. This paper first points to the typical length of high-voltage transmissions lines as a key consideration. Specifically, “[t]he typical distance between high-voltage nodes is about 100 km.” Id. at 1. Given GICs are calculated based on the geoelectric effects (i.e., induced currents) over the length of a transmission line, the selection of 100 km is both logical and appropriate. The 2015 GMD/GIC Scaling Paper goes on to state that since “GIC is basically proportional to the spatial integral of the geoelectric field along the transmission line, one usually does not need to consider smaller than about 100 km scale features.” Id. at 1. Therefore, the 2015 GMD/GIC Scaling Paper provides the justification for the selection of the first factor (i.e., 100 km subsections).

Regarding the choice of a 500 km wide square for spatial averaged wide area impacts, the Trade Associations also understand that the SDT conducted an iterative process to refine and define the optimally sized area for defining spatial averaged impacts to support studies for examining potential wide area BPS impacts. SDT concluded that the selection of an area too small would do little more than yield results that are more closely representative of localized impacts, which will cause the calculation of unrealistic values that distort wide area impacts. Given the process described in the 2015 GMD/GIC Scaling Paper as “only the beginning . . . exploration of spatial geoelectric field structures pertaining to extreme GIC,”<sup>17</sup> the Trade Associations believe that this approach provides a more reasonable and realistic basis over the use of a peak value that is clearly not representative of what transmission lines will be exposed to broadly during a severe geomagnetic storm. Further, the Trade Associations note that the authors are in the process of conducting analyses to quantify the spatial localization of the most

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<sup>17</sup> Id., <http://www.earth-planets-space.com/content/pdf/s40623-015-0255-6.pdf>, at 6.

extreme geoelectric fields and to study the power engineering implications of extreme fields at different spatial scales, which over time will yield more improvements in both the understanding of the geoelectric impacts of solar storms on the BPS and inform NERC on other enhancements that might be necessary over time.

**C. The Trade Associations support the scaling factor developed by the Standards Drafting Team for lower latitudes.**

The NOPR seeks comment on whether, in light of studies indicating that GMD events could have pronounced effects on lower geomagnetic latitudes, a modification is warranted to reduce the impact of the scaling factors. See NOPR at P 37.

The Trade Associations do not believe that the papers cited in the NOPR offer any meaningful new information that might suggest or inform changes to the scaling factors developed by the NERC SDT in TPL-007-1.<sup>18</sup> The Trade Associations understand that the geomagnetic latitude scaling factors in the proposed Reliability Standard were developed “from a large number of global geomagnetic field observations of all major geomagnetic storms since the late 1980s.”<sup>19</sup> In contrast, results contained in models in the 2014 Space Physics<sup>20</sup> paper remain highly theoretical and not sufficiently validated. Although the Trade Associations support such studies as improving the underlying scientific foundation<sup>21</sup> for mandatory reliability requirements, the Commission is far better served at this time by relying on actual historical

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<sup>18</sup> *Reliability Standard for Transmission System Planned Performance for Geomagnetic Disturbance Events*, Notice of Proposed Rulemaking, 151 FERC ¶ 61,134 (2015).

<sup>19</sup> See NERC GMD Benchmark White Paper.

<sup>20</sup> Ngwira, C. M., Pulkkinen, A., Kuznetsova, M. M., Gloer, A., “Modeling extreme ‘Carrington-type’ space weather events using three-dimensional global MHD simulations,” 119 *Journal of Geophysical Research: Space Physics* 4472 (2014) (“2014 Space Physics”).

<sup>21</sup> EEI views the comments filed on July 24 in this docket by scientists at the U.S. Geological Survey as concurring with the view that the underlying science is very young and evolving quickly.

observations. As applied scientific inquiry advances, models are refined, and data collected and analyzed, the Commission can look forward to a stronger record to consider further modifications. While the Trade Associations firmly believe that over time the research and modeling will better inform the industry in ways that will improve industry standards and response to geomagnetic disturbances, it is inappropriate to modify the scaling factors based on as yet not validated theoretical modeling, without first determining that historical field observations are either incorrect or an incorrect prediction of future GMD patterns in lower latitudes.

The NOPR also refers to a paper written in 2007 that described transformer failures on the Eskom grid (South Africa) that occurred in 2003.<sup>22</sup> Although the 2007 Gaunt Paper implicates GICs as the causal factor for these transformer failures, the authors recognized that other factors were likely involved. Moreover, the levels of GIC mentioned in the paper are far below those considered to be harmful to well-designed transformers. In addition, other authorities have concluded that “[c]ases of significant overheating and winding damage, reported in the published literature as have been solely caused by GIC, were found to have been caused totally, or partially, by other effects, or by system instability experienced during or after the GIC event.”<sup>23</sup> The Trade Associations further understand that these failures were in part caused by transformer oil <sup>24</sup> that was contaminated by copper sulfide. Therefore, the Trade Associations

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<sup>22</sup> Gaunt, C. T., Coetzee, G., “Transformer Failures in Regions Incorrectly Considered to have Low GIC-Risk,” IEEE Lausanne 807 (July 2007) (“2007 Gaunt Paper”).

<sup>23</sup> R. Girgis, K. Vedante, and K. Gramm, “Effects of Geomagnetically Induced Currents on Power Transformers and Power Systems,” paper no. A2-304 (CIGRE, 2012), at 8.

<sup>24</sup> See *id.* at 55 (“These incidents were found to coincide with failures caused by the phenomenon of the conducting Copper Sulphide forming and causing failures of transformers world – wide; related to the Sulphur content in the mineral oil used in these transformers.”).

view the paper as providing no new insights beyond what was already well known long before the scaling factors were developed. Moreover, issues surrounding copper sulfide contamination are now well understood and controlled worldwide and in North America, and it is not expected that it would be a contributing factor affecting transformers moving forward.

For all the reasons set forth in these comments, and by NERC in its filing and the record of the development of TPL-007-1, the Trade Associations strongly support the scaling factors developed by the NERC SDT. In addition, the Trade Associations ask that the Commission recognize the Space Physics and Gaunt papers as offering no support in consideration of directing changes to the proposed scaling factors.

**D. The Trade Associations do not support the NOPR proposal to conduct transformer impacts studies using both spatial averaged and non-spatial averaged peak benchmarks to assess transformer thermal impacts.**

The Commission proposes to direct NERC to modify the Reliability Standard to require responsible entities to apply spatially averaged and non-spatially averaged peak geoelectric field values, or some equally efficient and effective alternative, when conducting thermal impact assessments. See NOPR at P 43. The NOPR also seeks comment as to why qualifying transformers are not assessed for thermal impacts using the maximum GIC-producing orientation. The Commission questions why the effective GIC time series described in Requirement 5.2 is used to assess transformer thermal impacts rather than the maximum effective GIC value for the worst case geoelectric field orientation. See NOPR at P 44.

The Trade Associations do not support the Commission's proposal to require entities to conduct thermal impact assessments based on both spatially averaged and non-spatially averaged

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peak geo-electric field values. The proposed standard correctly requires a single test based on the spatially averaged benchmark. The Trade Associations emphasize that the selection of this spatially averaged benchmark was intended to reflect real-world impacts across a wide area and was never intended to address specific localized areas that might experience peak conditions and affect what we understand to be a very small number of assets that are unlikely to initiate a cascading outage. Although the Trade Associations understand the Commission's concern for the individual transformer assets, the purpose of Reliability Standards is not to ensure the complete protection of all assets but rather "to provide for reliable operation of the bulk-power system."<sup>25</sup> Therefore, the Trade Associations believe that NERC through the Commission-approved standard development process have met that standard with TPL-007-1 and the Commission should approve it.

The operation of any BPS element includes some risk of equipment failure. While a severe GMD event presents some level of risk of equipment damage, the Trade Associations are confident that the proposed Standard in conjunction with other Reliability Standards, such as the Commission approved EOP-010-1, will allow those entities the flexibility to utilize additional protections and safeguards that go beyond those needed to assure BPS reliability.<sup>26</sup>

The Trade Associations believe that the NERC SDT correctly selected an effective GIC time series for assessing the thermal impacts on transformers during geomagnetic storms. Application of the maximum effective GIC value without adjustment to time and without consideration of the known and recorded characteristics of a severe GMD event would cause an

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<sup>25</sup> FPA section 215 (a)(3).

<sup>26</sup> For example, some entities may have good cause to believe such additional protections and safeguards are due given their particular geomagnetic latitude or because of some other aspect of its risk profile.

unrealistic assessment of the actual thermal impacts on transformers. Moreover, the NERC Transformer Thermal Impact Assessment White Paper states “[t]he thermal time constants of transformer windings and metallic parts are typically on the order of minutes to tens of minutes; therefore, hot spot temperatures are heavily dependent on GIC history and rise time, amplitude and duration of GIC in the transformer windings, bulk oil temperature due to loading, ambient temperature and cooling mode.”<sup>27</sup> Therefore, the Trade Associations believe that NERC and the NERC SDT correctly chose to assess transformer impacts based on known and recorded “geomagnetic field measurement record of the March 13-14, 1989, GMD event, measured at NRCan’s Ottawa geomagnetic observatory.”<sup>28</sup>

For these reasons, the Trade Associations support the process and methods contained in the proposed Reliability Standard and ask the Commission to not direct changes at this time, and to conclude that these processes will ensure that transformers are sufficiently tested to maintain reliable operations of the BPS.

### **III. The Trade Associations do not support the NOPR proposal to direct NERC to revise the Proposed Reliability Standard to require the installation of monitoring devices.**

The NOPR proposes to direct NERC to revise TPL-007-1 to require the installation of monitoring equipment (i.e., GIC monitors and magnetometers) to the extent that there are any gaps in existing GIC monitoring and magnetometer networks. See NOPR at P 46. Alternatively, the Commission seeks comment on whether NERC itself should be responsible for installation of any additional, necessary magnetometers while affected entities would be responsible for

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<sup>27</sup> NERC Transformer Thermal Impact Assessment White Paper, Thermal response simulation, at 5.

<sup>28</sup> See NERC Benchmark GMD Event Description, Reference Geomagnetic Field Waveshape, at 5. The Trade Associations understand this geomagnetic field measurement was selected in order to provide both a conservative and rigorous assessment of the thermal impacts on power transformers.

installation of additional, necessary GIC monitors. Additionally, the Commission proposes as part of NERC's work plan that NERC identify the number and location of current GIC monitors and magnetometers in the United States to assess whether there any gaps. *Id.*

While the Trade Associations agree on the importance of GIC and magnetometer data with respect to providing analytical validation and situational awareness, the Trade Associations do not agree with the NOPR's approach on revising the Proposed Reliability Standard for this purpose. See NOPR at P 46.

Instead of addressing this issue in the context of a mandatory reliability planning standard, an alternative can be to have NERC to develop a plan that helps describes the path forward for modeling and assessment of severe space weather, and how to leverage such assessments with space weather technical experts. In addition, both the NERC Operating Committee and Planning Committee might assist NERC in development of the plan.

The Commission's proposal to direct NERC to revise TPL-007-1 to require the installation of monitoring equipment is contrary to the Commission's previous statements in Order No. 779 that industry will be given sufficient flexibility on how best to mitigate the potential impacts of GMDs. In Order No. 779, the Commission stated it would "not direct [NERC] to develop Reliability Standards that require the use of . . . any specific technology. We agree with NERC that the Reliability Standards should be *technology-neutral*." Order No. 779 at P 81 (emphasis added). The Commission has also expressed its preference that the GMD standards afford the needed flexibility for responsible entities to comply based on their specific circumstances and equipment. *Id.* at P 70; see also Order No. 797 at P 14 (approving EOP-010-1). This Commission policy is consistent with NERC's objective of moving away from

prescriptive standards in favor of results- or performance-based standards.<sup>29</sup>

The Trade Associations propose that the Commission's goals can be better achieved by a government and industry partnership that would leverage the talents and expertise of multiple groups while allowing entities to take their own unique circumstances into account (i.e., GIC monitors) and ensuring that the collected data will be readily available for both industry and academic research purposes. Moreover, setting rigid and inflexible standards for the installation of monitoring equipment might limit the usefulness of the data possibly impacting its usefulness for other purposes (e.g. academic research) while not leveraging the expertise of industry subject matter experts. . Furthermore, such an approach might hinder the industry's ability to choose the best approach or combination of approaches to mitigate GMD events on the BPS .

Although the Trade Associations do not agree with any directive that might require NERC to install GMD monitoring equipment, if the Commission decides to move forward with this proposal, then the Commission should also direct NERC to consider the cost impacts of this directive. The cost of installing monitoring equipment as well as supporting communications (or leased data services) could be substantial, depending on the network identified by NERC, which could greatly impact ratepayers already paying for a multitude of other Reliability Standards compliance efforts. To allow NERC and industry to fully assess these costs, and to ensure that the ultimate costs match up with benefits to be achieved in an efficient manner, the Commission should direct NERC to explicitly consider costs when determining the number and location of

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<sup>29</sup> See, e.g. North American Electric Reliability Corporation, 150 FERC ¶ 61,108 (2015) (Order approving NERC's implementation of the Reliability Assurance Initiative in which NERC plans to transition to a risk-based approach for compliance monitoring and enforcement

monitoring devices.

To achieve this result, NERC could conduct a cost study, propose strategies for keeping costs down, or file informational reports with the Commission on the costs incurred as a result of this directive. Such measures would help ensure that costs are kept low while still achieving the reliability objectives of this standard, which is an important balance given that GMDs are a high impact, low frequency type of event. The Commission has previously acknowledged “the potential costs of GMD Reliability Standards” and stated its expectation that “NERC and industry will consider the costs and benefits of particular mitigation measures.” See Order No. 779 at P 28. Now that the Commission is considering directing NERC to implement a specific type of mitigation measure, the Commission should allow NERC to first ensure that the benefits justify the high costs.

Similarly, if the Commission decides to go forward with this proposal, the Trade Associations urge the Commission to clarify that enough monitoring devices be installed to provide adequate situational awareness as well as provide a sufficiently dense network which might allow academia to enhance ongoing research into this phenomenon. The NOPR currently proposes to require “the installation and collection of data from GIC monitors and magnetometers in enough locations to provide adequate analytical validation and situational awareness.” NOPR at P 48 (emphasis added). The phrase “adequate analytical validation” refers to the system models and GIC system models required by TPL-007-1, but how much analysis would be considered “adequate” is unclear. This phrase should be removed as it introduces uncertainty into the equation. On the other hand, the phrase “situational awareness” is

clearly defined and well understood by industry.<sup>30</sup> In the interest of avoiding the use of vague or unclear terminology, the Commission should only require sufficient monitoring devices be installed to provide for situational awareness of GMDs.

The NOPR asks whether FERC should adopt a policy specifically allowing entities to recover costs associated with complying with TPL-007-1. See NOPR at P 49. The Trade Associations support the development of FERC policy ensuring cost recovery for the costs to comply with Proposed Reliability Standard TPL-007-1 and for GIC monitors and magnetometers. The Trade Associations agree and encourage the Commission to set clear policy ensuring that both the costs associated with the installation of monitors as well as other costs of mitigating or remediating identified impacts associated with GMD events can be recovered by owners of both transmission and generation assets affected by TPL-007-1. Such cost recovery is especially appropriate due to the nature of this standard – a high impact, low frequency event that goes beyond the level of Reliability Standards that historically have been used. Moreover, entities that may be affected, such as generators, may have no direct method to recover such costs through current rate schedules assets affected by TPL-007-1. These are extraordinary costs that could not be anticipated when generators went into service.

**IV. The Trade Associations support the NOPR proposal for corrective action plan deadlines and recommend that the Commission direct NERC to establish a mechanism for utilities to seek extensions of required deadlines.**

In the NOPR, the Commission proposes to direct NERC to revise the Proposed Reliability Standard to include deadlines concerning the development and implementation of corrective action plans under Requirement R7. See NOPR at P 51. The Trade Associations

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<sup>30</sup> For example, the U.S. Department of Energy has defined situational awareness as “the accuracy of a person’s current knowledge and understanding of actual conditions compared to expected conditions at a given time.” See Human Performance Improvement Handbook, Vol. 2, at 5 (June 2009).

agree that the current Requirement R7 does not establish such deadlines in the manner that is provided in other NERC Reliability Standards and providing deadlines under Requirement R7 would be consistent with the definition of “corrective action” plan as defined in the NERC Glossary. *Id.* at P 52. Additionally, the Trade Associations believe that the specific deadlines proposed for the corrective action plans are fair and reasonable. *Id.* at P 53.

The Trade Associations support development of a mechanism that would allow NERC to consider, on a case-by-case basis, requests for extensions of required deadlines, and support the Commission proposal to direct NERC to provide such a mechanism in the proposed Reliability Standard. See NOPR at 54. Utilities must have a mechanism to seek additional time, particularly where they may encounter issues of both availability and other technical challenges that may delay deliveries and installation of equipment related mitigation.

**V. The Trade Associations believe that the requirement within the Proposed Reliability Standard concerning minimization of load loss and curtailment is appropriate.**

The NOPR seeks comment from NERC regarding the provision in Table 1 that “Load loss or curtailment of Firm Transmission Service should be minimized” and expresses concern that this language may be vague and not be enforceable. See NOPR at P 57.

The Trade Associations agree with the Commission that the qualifying condition for minimizing loss of load could provide significant challenges in compliance and enforcement. The Trade Associations also agree with the Commission’s view that mandatory standards cannot protect against all GMD-induced outages.<sup>31</sup> The condition of minimizing loss of load has no supporting technical definitions or measures, and cannot be applied without understanding the

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<sup>31</sup> See e.g. Order No. 779, at P 26

facts and circumstances surrounding an event. As stated in the NOPR, the term lacks objective criteria. *Id.* Moreover, transmission operators seek flexibility to address real-time conditions to sustain reliability, and not to consider potential compliance consequences of their actions. The Trade Associations have concerns that the application of this condition during a severe GMD event could limit operators' actions in real-time, and therefore increase reliability risks during conditions when such limits would be invoked. While the Trade Associations support the approval of TPL-007, the Commission should consider whether such language in mandatory requirements invites the unintended consequences of raising reliability risks, especially during real-time emergency conditions. In the interim, the Trade Associations envision that NERC will consider further discussions with stakeholders on the issue prior to TPL-007 implementation.

**VI. The Trade Associations Support NERC's Proposed Implementation Plan and Effective Dates for Reliability Standard TPL-007-1, Which Should Not Be Shortened.**

While the Commission proposes to approve NERC's five-year implementation plan and effective dates for Proposed Reliability Standard TPL-007-1, it expresses concern with the duration of the timeline associated with mitigation stemming from a corrective action plan under the standard. See NOPR at P 63. The Commission seeks comment on whether the length of the implementation plan could reasonably be shortened, specifically with respect to Requirements R4 through R7. *Id.*

The Trade Associations fully support NERC's proposal to implement TPL-007-1 over a phased five-year period, which is essential to ensure that entities are provided with sufficient time to obtain tools and data, and to develop the models that are needed to undertake the thorough GMD vulnerability assessments prescribed under the proposed standard, as well as to develop corrective actions plans that are well-conceived and viable in practice. As NERC notes

in its Petition at 34-35, much of the GIC modeling and thermal impact assessments that are called for under TPL-007-1, requirements R2 and R6, will be developed and compiled by applicable entities for the first time. Also, the sequential nature of these assessments means that entities' evaluation of thermal impacts on transformers depends upon their GIC flow calculations.<sup>32</sup> Sufficient time is thus needed for analysis and coordination to allow this successive process to function and, in turn, to provide for more thorough assessments. Further, NERC's proposed implementation plan accounts for potential issues related to the availability of validated tools, models, and data that are necessary to perform GMD vulnerability assessments.

In addition, the five-year phased implementation approach developed and proposed by NERC is appropriate to ensure applicable entities have adequate time to develop corrective action plans that are feasible in order to appropriately prioritize and address any GMD-related impacts to the grid that are identified through entities' GMD vulnerability assessments and related modeling.<sup>33</sup> As NERC notes in its petition seeking approval of TPL-007, these plans may require entities to develop and validate new or modified studies and procedures to meet the TPL-007-1 requirements, and in some instances may lead to mitigation measures that require entities to satisfy siting and construction planning requirements.<sup>34</sup> Therefore, a five-year phased approach to implementation of the standard is the most appropriate, feasible and realistic way of addressing vulnerabilities to the grid that are posed by GMDs, and the Trade Associations urge the Commission to approve NERC's implementation plan for TPL-007-1 as proposed.

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<sup>32</sup> See NERC Petition for Approval of TPL-007-1, Exhibit B (Implementation Plan for TPL-007-1), at 2 (filed Jan. 21, 2015).

<sup>33</sup> See NERC Petition at 46.

<sup>34</sup> See NERC Petition at 34-35; Exhibit B at 2.

## CONCLUSION

**WHEREFORE**, for the foregoing reasons, the Trade Associations urge the Commission to consider these comments and ensure that any future action ordered as a result of this proceeding is consistent as discussed above.

Respectfully submitted,

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**CERTIFICATE OF SERVICE**

I hereby certify that I have this day served the foregoing document upon each person designated on the official service list compiled by the Secretary in this proceeding.

Dated at Washington, DC this 27th day of July, 2015.

Respectfully Submitted,

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