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using the latest developments in GMD research to provide enhanced criteria and requirements to address reliability risks arising from GMDs, including the risks posed by severe, localized events.

NERC requests that the Commission approve the proposed Reliability Standard and related elements as just, reasonable, not unduly discriminatory or preferential, and in the public interest. NERC requests that the Commission approve the proposed standard effective on the first day of the first calendar quarter that is three months after the effective date of the Commission's order approving the proposed standard in accordance with the proposed implementation plan (Exhibit B). As described in further detail herein, the proposed implementation plan is intended to integrate the new requirements in TPL-007-2 with the GMD Vulnerability Assessment<sup>5</sup> process that is currently being implemented through the currently-effective version of the standard.

Pursuant to Section 39.5(a) of the Commission's regulations,<sup>6</sup> this Petition presents the technical basis and purpose of proposed Reliability Standard TPL-007-2 (Exhibits A – D and Exhibits G – J), a summary of the development history (Exhibit D), and a demonstration that the proposed Reliability Standard meets the criteria identified by the Commission in Order No. 672 (Exhibit E).<sup>7</sup>

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<sup>5</sup> Unless otherwise designated, all capitalized terms shall have the meaning set forth in the *Glossary of Terms Used in NERC Reliability Standards*, available at [http://www.nerc.com/files/Glossary\\_of\\_Terms.pdf](http://www.nerc.com/files/Glossary_of_Terms.pdf).

<sup>6</sup> 18 C.F.R. § 39.5(a).

<sup>7</sup> The Commission specified in Order No. 672 certain general factors it would consider when assessing whether a particular Reliability Standard is just and reasonable. *See Rules Concerning Certification of the Electric Reliability Organization; and Procedures for the Establishment, Approval, and Enforcement of Electric Reliability Standards*, Order No. 672, FERC Stats. & Regs. ¶ 31,204, at PP 262, 321-37, *order on reh'g*, Order No. 672-A, FERC Stats. & Regs. ¶ 31,212 (2006).

## I. EXECUTIVE SUMMARY

Proposed Reliability Standard TPL-007-2 adds enhancements to the currently-effective GMD planning standard, Reliability Standard TPL-007-1, to better address risks to reliability posed by GMDs and to implement the Commission's directives in Order No. 830. In Order No. 830, the Commission approved Reliability Standard TPL-007-1 and directed NERC to modify the standard as follows:

- revise the benchmark GMD event used for GMD Vulnerability Assessments so that the reference peak geoelectric field amplitude component is not based solely on spatially-averaged data;<sup>8</sup>
- revise Requirement R6 to require entities to apply spatially averaged and non-spatially averaged peak geoelectric field values, or some equally efficient and effective alternative, when conducting transformer thermal impact assessments;<sup>9</sup>
- require entities to collect data from geomagnetically induced current ("GIC") monitors and magnetometers as necessary to enable model validation and situational awareness;<sup>10</sup> and
- require entities to develop any necessary Corrective Action Plans within one year from the completion of the GMD Vulnerability Assessment, include a two-year deadline for the implementation of non-hardware mitigation, and include a four-year deadline to complete hardware mitigation.<sup>11</sup>

Proposed Reliability Standard TPL-007-2 reflects the latest in GMD understanding and provides a technically sound and flexible approach to addressing the items of concern noted by the Commission in Order No. 830. The proposed standard addresses the Commission's directives by:

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<sup>8</sup> See Order No. 830 at P 44.

<sup>9</sup> *Id.* at P 65.

<sup>10</sup> *Id.* at P 88.

<sup>11</sup> *Id.* at P 101-102.

- requiring entities to perform supplemental GMD Vulnerability Assessments based on the supplemental GMD event, a second defined event that accounts for localized peak effects of GMDs and which is based on individual station measurements (i.e. not spatially-averaged data);
- requiring entities to perform supplemental thermal impact assessments of applicable power transformers based on GIC information for the supplemental GMD event;
- requiring entities to implement process(es) to obtain GIC monitor and magnetometer data; and
- implementing the deadlines specified by the Commission in Order No. 830 for the development and completion of any necessary Corrective Action Plans to address system performance issues resulting from the benchmark GMD event.

As discussed in detail below, these revisions would enhance reliability by expanding GMD Vulnerability Assessments to include severe, localized impacts and by implementing new deadlines and processes to maintain accountability in the development, completion, and revision of entity Corrective Action Plans developed to address identified vulnerabilities. Further, the proposed revisions would improve the availability of GMD monitoring data that may be used to inform GMD Vulnerability Assessments. Through its ongoing GMD work, including the GMD Research Work Plan<sup>12</sup> and a forthcoming Request for Data or Information pursuant to Section 1600 of the NERC Rules of Procedure (“Section 1600 GMD Data Request”),<sup>13</sup> NERC expects to obtain useful inputs for continued evaluation of the technical basis that underpins the proposed standard.

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<sup>12</sup> In accordance with Order No. 830, NERC filed a preliminary work plan to conduct research on topics related to GMDs and their impacts on the reliability of the BPS (the “GMD Research Work Plan”). *See Geomagnetic Disturbance Research Work Plan of the North American Electric Reliability Corporation*, Docket No. RM15-11-002 (May 30, 2017). In accordance with the Commission’s October 19, 2017 *Order on GMD Research Work Plan*, NERC will file a final or otherwise updated GMD Research Work Plan on or before April 2018.

<sup>13</sup> NERC Rules of Procedure Section 1600. The NERC Rules of Procedure are available at <http://www.nerc.com/AboutNERC/Pages/Rules-of-Procedure.aspx>.

For these reasons and as discussed more fully in this Petition, NERC respectfully requests that the Commission approve the proposed standard as just, reasonable, not unduly discriminatory or preferential, and in the public interest.

## **II. NOTICES AND COMMUNICATIONS**

Notices and communications with respect to this filing may be addressed to:<sup>14</sup>

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## **III. BACKGROUND**

### **A. Regulatory Framework**

In the Energy Policy Act of 2005,<sup>15</sup> Congress entrusted the Commission with the duties of approving and enforcing rules to ensure the reliability of the BPS. Congress also entrusted the Commission with certifying an Electric Reliability Organization (“ERO”) charged with developing and enforcing mandatory Reliability Standards, subject to Commission approval. Section 215(b)(1) of the FPA states that all users, owners, and operators of the BPS in the United

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<sup>14</sup> Persons to be included on the Commission’s service list are identified by an asterisk. NERC respectfully requests a waiver of Rule 203 of the Commission’s regulations, 18 C.F.R. § 385.203, to allow the inclusion of more than two persons on the service list in this proceeding.

<sup>15</sup> 16 U.S.C. § 824o.

States will be subject to Commission-approved Reliability Standards.<sup>16</sup> Section 215(d)(5) of the FPA authorizes the Commission to order the ERO to submit a new or modified Reliability Standard.<sup>17</sup> Section 39.5(a) of the Commission’s regulations requires the ERO to file with the Commission for its approval each Reliability Standard that the ERO proposes should become mandatory and enforceable in the United States and each modification to a Reliability Standard that the ERO proposes should be made effective.<sup>18</sup>

The Commission is vested with the regulatory responsibility to approve Reliability Standards that protect the reliability of the BPS and to ensure that such Reliability Standards are just, reasonable, not unduly discriminatory or preferential, and in the public interest. Pursuant to Section 215(d)(2) of the FPA<sup>19</sup> and Section 39.5(c) of the Commission’s regulations, “the Commission will give due weight to the technical expertise of the Electric Reliability Organization” with respect to the content of a Reliability Standard.<sup>20</sup>

## **B. NERC Reliability Standards Development Procedure**

The proposed Reliability Standard was developed in an open and fair manner and in accordance with the Commission-approved Reliability Standard development process.<sup>21</sup> NERC develops Reliability Standards in accordance with Section 300 (Reliability Standards Development) of its Rules of Procedure and the NERC Standard Processes Manual.<sup>22</sup>

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<sup>16</sup> *Id.* § 824o(b)(1).

<sup>17</sup> *Id.* § 824o(d)(5).

<sup>18</sup> 18 C.F.R. § 39.5(a).

<sup>19</sup> 16 U.S.C. § 824o(d)(2).

<sup>20</sup> 18 C.F.R. § 39.5(c)(1).

<sup>21</sup> *Rules Concerning Certification of the Electric Reliability Organization; and Procedures for the Establishment, Approval, and Enforcement of Electric Reliability Standards*, Order No. 672 at P 334, FERC Stats. & Regs. ¶ 31,204, *order on reh’g*, Order No. 672-A, FERC Stats. & Regs. ¶ 31,212 (2006).

<sup>22</sup> The ROP is available at <http://www.nerc.com/AboutNERC/Pages/Rules-of-Procedure.aspx>. The NERC *Standard Processes Manual* is available at [http://www.nerc.com/comm/SC/Documents/Appendix\\_3A\\_StandardsProcessesManual.pdf](http://www.nerc.com/comm/SC/Documents/Appendix_3A_StandardsProcessesManual.pdf).

In its order certifying NERC as the Commission’s ERO, the Commission found that NERC’s proposed rules provide for reasonable notice and opportunity for public comment, due process, openness, and a balance of interests in developing Reliability Standards,<sup>23</sup> and thus satisfy certain of the criteria for approving Reliability Standards.<sup>24</sup> The development process is open to any person or entity with a legitimate interest in the reliability of the BPS. NERC considers the comments of all stakeholders, and stakeholders must approve, and the NERC Board of Trustees must adopt, a Reliability Standard before the Reliability Standard is submitted to the Commission for approval.

### **C. Procedural History of Proposed Reliability Standard TPL-007-2**

This section summarizes the development history of proposed Reliability Standard TPL-007-2.

#### **1. History of Reliability Standard TPL-007-1 and Order No. 830**

On January 21, 2015, NERC filed a petition requesting Commission approval of Reliability Standard TPL-007-1, the second-stage GMD Reliability Standard contemplated by the Commission in Order No. 779.<sup>25</sup> Reliability Standard TPL-007-1 requires applicable entities to conduct initial and ongoing assessments of the potential impact of a 1-in-100 year benchmark GMD event on BPS equipment and the BPS as a whole. The Commission approved Reliability Standard TPL-007-1 in Order No. 830, issued on September 22, 2016, stating that the standard “constitutes an important step in addressing the risks posed by GMD events to the Bulk-Power

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<sup>23</sup> *N. Am. Elec. Reliability Corp.*, 116 FERC ¶ 61,062 at P 250 (2006).

<sup>24</sup> Order No. 672 at PP 268, 270.

<sup>25</sup> *Petition of the North American Electric Reliability Corporation for Approval of Reliability Standard TPL-007-1 Transmission System Planned Performance for Geomagnetic Disturbance Events*, Docket No. RM15-11-000 (Jan. 21, 2015); *Reliability Standards for Geomagnetic Disturbances*, Order No. 779, 78 Fed. Reg. 30,747 (May 23, 2013), 143 FERC ¶ 61,147, *reh’g denied*, 144 FERC ¶ 61,113 (2013) (directing the development of Reliability Standards to address GMDs in two stages).

System.”<sup>26</sup> The Commission also directed four revisions to the standard to address areas of concern noted in the order and underlying proceeding.

First, noting its concerns with the reliance on spatially averaged data in the TPL-007-1 benchmark GMD event definition, the Commission directed NERC to “develop revisions to the benchmark GMD event definition so that the reference peak geoelectric field amplitude component is not based solely on spatially-averaged data.”<sup>27</sup> The Commission also directed NERC to revise Requirement R6 “to require registered entities to apply spatially averaged and non-spatially averaged peak geoelectric field values, or some equally and efficient alternative, when conducting thermal impact assessments.”<sup>28</sup>

Next, the Commission directed NERC to revise TPL-007-1 to require entities “to collect GIC monitoring and magnetometer data as necessary to enable model validation and situational awareness, including from any devices that must be added to meet this need.”<sup>29</sup> The Commission stated that “additional collection and disclosure of GIC monitoring and magnetometer data is necessary to improve our collective understanding of the threats posed by GMD events.”<sup>30</sup>

Lastly, the Commission directed NERC to modify TPL-007-1 requirements for Corrective Action Plans to include: (i) a one-year deadline for the development of any necessary Corrective Action Plans; (ii) a two-year deadline for the implementation of non-hardware mitigation; and (iii) a four-year deadline for the implementation of hardware mitigation.<sup>31</sup>

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<sup>26</sup> Order No. 830 at P 1.

<sup>27</sup> Order No. 830 at P 44.

<sup>28</sup> *Id.* at P 65.

<sup>29</sup> *Id.* at P 88.

<sup>30</sup> *Id.*

<sup>31</sup> *Id.* at PP 101-102.

In addition to these standard modification directives, the Commission also directed NERC to undertake certain activities to improve understanding of GMDs and their potential impacts on power systems. First, the Commission directed NERC to submit a work plan describing how NERC would research specific GMD-related topics identified by the Commission and other topics at NERC's discretion.<sup>32</sup> Second, the Commission directed NERC to collect GIC and magnetometer data pursuant to Section 1600 of the NERC Rules of Procedure, including existing data for the period beginning May 2013 and new data going forward, and to make that information available to support ongoing GMD research and analysis.<sup>33</sup>

This filing describes how proposed Reliability Standard TPL-007-2 addresses the standard modification directives described above. NERC continues its efforts to address the Commission's work plan and data collection directives and provides a status update on those efforts for the Commission's information in Section VI, below. NERC anticipates that the results of these efforts will inform future reviews of the proposed Reliability Standard.

## **2. Project 2013-03 Geomagnetic Disturbance Mitigation**

Shortly after the issuance of Order No. 830, NERC initiated a new phase of Project 2013-03 to address the Commission's directives to modify Reliability Standard TPL-007-1. As with prior phases of the project, the standard drafting team for this phase consisted of individuals with extensive planning, engineering, and scientific knowledge and experience. To provide technical support for proposed Reliability Standard TPL-007-2, the standard drafting team developed new and updated supporting materials, including the Supplemental GMD Event Description White

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<sup>32</sup> See generally *id.* at P 77.

<sup>33</sup> Order No. 830 at PP 89, 93.

Paper (Exhibit I), Screening Criterion for Transformer Thermal Impact Assessment White Paper (Exhibit H), and Transformer Thermal Impact Assessment White Paper (Exhibit G).

Proposed Reliability Standard TPL-007-2 was posted for initial ballot from June 28, 2017 to August 11, 2017 and for final ballot from October 20, 2017 to October 30, 2017. The NERC Board of Trustees adopted the proposed standard on November 9, 2017. The complete development history of proposed Reliability Standard TPL-007-2 is attached as Exhibit D.

#### **IV. JUSTIFICATION FOR APPROVAL**

As discussed below and in Exhibit E, proposed Reliability Standard TPL-007-2 satisfies the Commission's criteria in Order No. 672 and is just, reasonable, not unduly discriminatory or preferential, and in the public interest. The proposed Reliability Standard contains significant benefits for the BPS and addresses the Commission's directives from Order No. 830.

The purpose of proposed Reliability Standard TPL-007-2, which remains unchanged from currently-effective Reliability Standard TPL-007-1, is to “[e]stablish requirements for Transmission system planned performance during geomagnetic disturbance (GMD) events.” The applicability of the proposed standard also remains unchanged from TPL-007-1: the proposed standard would continue to apply to: (1) Planning Coordinators and Transmission Planners whose planning areas have a Facility that includes a power transformer with a high side, wye-grounded winding with terminal voltage greater than 200 kV<sup>34</sup>; and (2) Transmission Owners and Generator Owners that own a Facility that includes such equipment.

Currently-effective Reliability Standard TPL-007-1 requires entities to conduct initial and on-going assessments of the potential impact of the defined benchmark GMD event on BPS equipment and the BPS as a whole. Proposed Reliability Standard TPL-007-2 builds upon these

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<sup>34</sup> A power transformer with a “high side wye-grounded winding” refers to a power transformer with windings on the high voltage side that are connected in a wye configuration and have a grounded neutral connection.

Requirements and adds new Requirements for entities to assess their vulnerabilities to a second defined event, the supplemental GMD event. This supplemental GMD event is designed to account for the localized peak effects of severe GMD events on systems and equipment. The proposed standard also contains new Requirements for the collection of GIC and magnetometer data. Lastly, the proposed standard revises Requirement R7 to include deadlines for the development and completion of any necessary Corrective Action Plans. Each of these revisions and how they address the Commission's directives from Order No. 830 is discussed below.

**A. The Supplemental GMD Event**

Proposed Reliability Standard TPL-007-2 contains new Requirements for entities to assess their vulnerabilities to a second defined GMD event, the supplemental GMD event. As described in the Supplemental GMD Event Description White Paper (Exhibit I), geomagnetic fields during severe GMD events can be spatially non-uniform with higher and lower strengths across a geographic region. The supplemental GMD event, which was derived using individual station measurements rather than spatially averaged measurements, includes localized enhancement of field strength above the average value. As such, the proposed standard addresses the Commission's directive in Order No. 830 to revise the GMD standard to account for the effects of localized peaks that could potentially affect reliable operations.<sup>35</sup>

The benchmark GMD event and the supplemental GMD event are similar in structure but the supplemental GMD event contains several differences to account for localized impacts. Like

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<sup>35</sup> See Order No. 830 at P 44 ("The Commission...directs NERC to develop revisions to the benchmark GMD event definition so that the reference peak geoelectric field amplitude component is not based solely on spatially-averaged data."). See also Order No. 830 at P 47 ("Without pre-judging how NERC proposes to address the Commission's directive, NERC's response to this directive should satisfy the NOPR's concern that reliance on spatially-averaged data alone does not address localized peaks that could potentially affect the reliable operation of the Bulk-Power System.")

the benchmark GMD event, the supplemental GMD event defines the geomagnetic and geoelectric field values used to compute GIC flows for use in a GMD Vulnerability Assessment.

The benchmark GMD event is composed of the following components:

- a reference peak geoelectric field amplitude of 8 V/km derived from statistical analysis of historical magnetometer data;
- scaling factors to account for local geomagnetic latitude;
- scaling factors to account for local earth conductivity; and
- a reference geomagnetic field time series or waveform to facilitate time-domain analysis of GMD impact on equipment.

The supplemental GMD event has the same components, except that the reference peak geoelectric field amplitude is 12 V/km over a localized area (compared to 8 V/km) and the geomagnetic field time series or waveform includes a local enhancement.<sup>36</sup> These distinguishing characteristics of the supplemental GMD event are intended to represent conditions associated with localized enhancement of the geomagnetic field during a severe GMD event for use in assessing GMD impacts.

In developing the supplemental GMD event, the standard drafting team used data and information so that the peak geoelectric field does not rely on spatial averaging of geomagnetic field data. Like the value in the approved benchmark GMD event, the supplemental GMD event peak geoelectric field is a 1-in-100 year extreme value determined using statistical analysis of historical geomagnetic field data. The fundamental difference in the supplemental GMD event amplitude is that it is based on geomagnetic field observations taken at individual observation stations (i.e., localized measurements), instead of the spatially averaged geoelectric fields used in

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<sup>36</sup> See proposed Reliability Standard TPL-007-2 Attachment 1. See also Supplemental GMD Event Description White Paper (Exhibit I). The addition of a local enhancement to the supplemental GMD event waveform also causes some small changes in earth conductivity scaling factors, as explained in the white paper. These earth conductivity scaling factors for the supplemental GMD event are included in proposed TPL-007-2 Attachment 1.

the benchmark GMD event. The result of the extreme value analysis shows that the supplemental GMD event peak of 12 V/km is above the upper limit of the 95 percent confidence interval for a 100-year return interval, while the same confidence interval with spatially-averaged data (i.e., the benchmark GMD event) is 8 V/km. Thus, GMD Vulnerability Assessments based on the 12 V/km peak geoelectric field of the proposed supplemental GMD event are considering extreme localized conditions associated with a 1-in-100 year severe GMD event.

Similar to the benchmark GMD event, the supplemental GMD event includes a waveform for assessing transformer thermal impacts from a severe GMD event. Both the benchmark and supplemental GMD event waveforms are based on 10-second sampling interval magnetic field data from the Ottawa observatory recorded during the March 13-14, 1989 GMD event. The supplemental GMD event waveform is more severe than the benchmark GMD event waveform because it includes a five-minute duration enhanced peak up to 12 V/km for the reference earth model and 60 degree geomagnetic latitude. This synthetic enhancement represents the observed localized, rapid magnetic field variation periods associated with ionospheric sources during some severe GMD events. Such GMD conditions could result in increased transformer heating for short durations during a severe GMD event due to increased GIC flows.

The supplemental GMD event provides a technically justified method of assessing vulnerabilities to the localized peak effects of severe GMD events, thereby addressing the Commission's Order No. 830 directive. Together, the approved benchmark GMD event and the proposed supplemental GMD event provide a high threshold for assessing GMD impacts.

**B. New and Revised Requirements to Perform GMD Vulnerability Assessments Based on the Supplemental GMD Event**

Proposed TPL-007-2 adds new Requirements R8, R9, and R10 to require responsible entities to assess the potential implications of the supplemental GMD event described above on their equipment and systems in accordance with the Commission’s directives in Order No. 830.<sup>37</sup> The proposed Requirements are structured and worded similarly to approved Requirements R4 through R6, which require entities to assess the impact of the benchmark GMD event. With the addition of these new Requirements, NERC proposes minor revisions to Requirements R4 through R6 to clarify that those existing Requirements pertain to assessments based on the benchmark GMD event. NERC also proposes revisions to Requirements R1 through R3 to include appropriate references to the supplemental GMD event. These minor revisions are shown in Exhibit A (redline).

**1. Proposed Requirement R8**

Proposed Requirement R8 would require responsible entities to complete a supplemental GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon at least once every five years. The proposed Requirement reads as follows:

- R8.** Each responsible entity, as determined in Requirement R1, shall complete a supplemental GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon at least once every 60 calendar months. This supplemental GMD Vulnerability Assessment shall use a study or studies based on models identified in Requirement R2, document assumptions, and document summarized results of the steady state analysis.
- 8.1.** The study or studies shall include the following conditions:
    - 8.1.1.** System On-Peak Load for at least one year within the Near-Term Transmission Planning Horizon; and
    - 8.1.2.** System Off-Peak Load for at least one year within the Near-Term Transmission Planning Horizon.
  - 8.2.** The study or studies shall be conducted based on the supplemental GMD event described in Attachment 1 to determine whether the System meets the

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<sup>37</sup> See Order No. 830 at P 44 (benchmark GMD event definition) and P 65 (transformer thermal impact assessments).

performance requirements for the steady state planning supplemental GMD event contained in Table 1.

- 8.3.** If the analysis concludes there is Cascading caused by the supplemental GMD event described in Attachment 1, an evaluation of possible actions designed to reduce the likelihood or mitigate the consequences and adverse impacts of the event(s) shall be conducted.
- 8.4.** The supplemental GMD Vulnerability Assessment shall be provided: (i) to the responsible entity's Reliability Coordinator, adjacent Planning Coordinators, adjacent Transmission Planners within 90 calendar days of completion, and (ii) to any functional entity that submits a written request and has a reliability-related need within 90 calendar days of receipt of such request or within 90 calendar days of completion of the supplemental GMD Vulnerability Assessment, whichever is later.
  - 8.4.1.** If a recipient of the supplemental GMD Vulnerability Assessment provides documented comments on the results, the responsible entity shall provide a documented response to that recipient within 90 calendar days of receipt of those comments.

Proposed Requirement R8 mirrors Requirement R4, which requires entities to complete a GMD Vulnerability Assessment based on the benchmark GMD event, but with one key difference. Proposed Requirement R8 contains an additional Part, Part 8.3, which provides that if analysis concludes there would be Cascading caused by the supplemental GMD event, the responsible entity must then evaluate possible actions to reduce the likelihood or mitigate consequences and adverse impacts of the event. As discussed more fully in Section IV.D below, the standard drafting team determined that requiring such an evaluation of possible actions, as opposed to a formal Corrective Action Plan, would provide a more prudent approach in light of the limitations of currently-available tools for modeling localized GMD effects.

New language is reflected in proposed Requirement R8 Part 8.4 to clarify the timeframe for providing completed supplemental GMD Vulnerability Assessments to the Reliability Coordinator, neighboring Planning Coordinators and Transmission Planners, and to the other functional entities with a reliability-related need that submit a request. To provide for

consistency across similar Requirements, conforming revisions are proposed in TPL-007-2 Requirement R4 Part 4.3 pertaining to benchmark GMD Vulnerability Assessments.

## **2. Proposed Requirements R9 and R10**

Proposed Requirements R9 and R10 pertain to supplemental transformer thermal impact assessments. As these Requirements are based on the supplemental GMD event described above, they address the Commission's directive to revise the standard to require entities to apply non spatially-averaged peak geoelectric field values when conducting thermal impact assessments.<sup>38</sup>

Proposed Requirement R9 would require responsible entities to provide GIC flow information based on the supplemental GMD event to owners of applicable BES power transformers in the planning area. The proposed Requirement mirrors existing Requirement R5 pertaining to GIC flow information for the benchmark GMD event. Proposed Requirement R9 reads as follows:

- R9.** Each responsible entity, as determined in Requirement R1, shall provide GIC flow information to be used for the supplemental thermal impact assessment of transformers specified in Requirement R10 to each Transmission Owner and Generator Owner that owns an applicable Bulk Electric System (BES) power transformer in the planning area. The GIC flow information shall include:
- 9.1.** The maximum effective GIC value for the worst case geoelectric field orientation for the supplemental GMD event described in Attachment 1. This value shall be provided to the Transmission Owner or Generator Owner that owns each applicable BES power transformer in the planning area.
  - 9.2.** The effective GIC time series, GIC(t), calculated using the supplemental GMD event described in Attachment 1 in response to a written request from the Transmission Owner or Generator Owner that owns an applicable BES power transformer in the planning area. GIC(t) shall be provided within 90 calendar days of receipt of the written request and after determination of the maximum effective GIC value in Part 9.1.

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<sup>38</sup>

Order No. 830 at P 65.

Proposed Requirement R10 would require each Transmission Owner and Generator Owner to conduct a supplemental thermal impact assessment for solely and jointly owned applicable BES power transformers where the maximum effective GIC value resulting from Requirement R9 is above a specific threshold. The proposed Requirement reads as follows:

- R10.** Each Transmission Owner and Generator Owner shall conduct a supplemental thermal impact assessment for its solely and jointly owned applicable BES power transformers where the maximum effective GIC value provided in Requirement R9, Part 9.1, is 85 A per phase or greater. The supplemental thermal impact assessment shall:
- 10.1.** Be based on the effective GIC flow information provided in Requirement R9;
  - 10.2.** Document assumptions used in the analysis;
  - 10.3.** Describe suggested actions and supporting analysis to mitigate the impact of GICs, if any; and
  - 10.4.** Be performed and provided to the responsible entities, as determined in Requirement R1, within 24 calendar months of receiving GIC flow information specified in Requirement R9, Part 9.1.

Proposed Requirement R10 mirrors existing Requirement R6 pertaining to transformer thermal impact assessments based on the benchmark GMD event. However, for the supplemental thermal impact assessment, the threshold is a maximum effective GIC value of 85 A per phase or greater (compared to the benchmark threshold of 75 A per phase or greater). As described in greater detail in the Screening Criterion for Transformer Thermal Impact Assessment White Paper (Exhibit H), the threshold value is determined using the same methods employed for the benchmark thermal impact assessments and provides that assessments be performed on all applicable power transformers that could potentially exceed emergency loading temperature guidelines.<sup>39</sup>

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<sup>39</sup> See generally Exhibit H and Institute of Electrical and Electronic Engineers (IEEE) Standard C57.91-2011 – Guide for Loading Mineral-Oil-Immersed Transformers and Step-Voltage Regulators.

### C. New Requirements for the Collection of GMD Data (R11 and R12)

In Order No. 830, the Commission directed NERC to “develop revisions to Reliability Standard TPL-007-1 to require responsible entities to collect GIC monitoring and magnetometer data as necessary to enable model validation and situational awareness, including from any devices that must be added to meet this need.”<sup>40</sup> Consistent with this directive, proposed TPL-007-2 contains two new Requirements, Requirements R11 and R12, that would require responsible entities to implement a process to obtain GIC monitor and geomagnetic field data for their planning area or system model area. The Requirements apply to Planning Coordinators and Transmission Planners, as determined in Requirement R1, because these entities are responsible for maintaining GIC System models (Requirement R2). Entities may use the data for validating GIC system models as well as for awareness of local geomagnetic conditions and measured GIC levels.

Proposed Requirement R11 would require responsible entities to implement a process to obtain GIC monitor data as follows:

**R11.** Each responsible entity, as determined in Requirement R1, shall implement a process to obtain GIC monitor data from at least one GIC monitor located in the Planning Coordinator’s planning area or other part of the system included in the Planning Coordinator’s GIC System model.

Consistent with the Commission’s guidance,<sup>41</sup> collection criteria are included in the Supplemental Material section of the proposed standard to promote consistency and provide entities with flexibility to tailor procedures to their planning area. The guidance for GIC data collection addresses monitor locations, monitor specifications, sampling interval, collection periods, data format, and data retention.

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<sup>40</sup> Order No. 830 at P 88.

<sup>41</sup> *See id.* at P 91 (regarding criteria for NERC to consider in developing a requirement for the collection of GIC monitoring data).

Proposed Requirement R12 would require responsible entities to implement a process to obtain geomagnetic field data as follows:

**R12.** Each responsible entity, as determined in Requirement R1, shall implement a process to obtain geomagnetic field data for its Planning Coordinator's planning area.

By requiring responsible entities to obtain geomagnetic field data for their planning areas, the proposed Requirement would ensure that data is obtained from diverse geographic areas of the North American BPS. Entities are advised to obtain data from the nearest accessible magnetometer. Sources of magnetometer data include government observatories, installed equipment owned or operated by the entity, and third party sources, including research institutions and universities. Entities that choose to install their own magnetometers are referred to the *INTERMAGNET Technical Reference Manual* for equipment specifications and data format protocols.

Proposed Reliability Standard TPL-007-2 supports future data collection across the North American BPS by requiring planning entities to implement processes for obtaining GMD data for each planning area. NERC, pursuant to the pending Section 1600 GMD Data Request,<sup>42</sup> will collect GMD data from entities and make that data available to support ongoing research and analysis of GMD risk. The proposed standard, together with the pending Section 1600 GMD Data Request, would thus satisfy the Commission's data collection directives in Order No. 830 and provide data to help address the potential reliability risks posed by GMDs.

#### **D. Revised Deadlines for Corrective Action Plans in Requirement R7**

NERC proposes to revise Requirement R7 to include the Commission-directed deadlines for the development and completion of any required Corrective Action Plans to address system

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<sup>42</sup> See Section VI *infra*.

performance issues for the benchmark GMD event. In Order No. 830, the Commission directed NERC to modify the TPL-007 standard to include the following deadlines:

- one year from the completion of the GMD Vulnerability Assessment to complete the development of a Corrective Action Plan;
- two years after the development of the Corrective Action Plan to complete the implementation of non-hardware mitigation; and
- four years after the development of the Corrective Action Plan to complete hardware mitigation.”<sup>43</sup>

Proposed TPL-007-2 Requirement R7 revises the existing standard to incorporate these directives as follows:

**R7.** Each responsible entity, as determined in Requirement R1, that concludes, through the benchmark GMD Vulnerability Assessment conducted in Requirement R4, that their System does not meet the performance requirements ~~of~~ for the steady state planning benchmark GMD event contained in Table 1, shall develop a Corrective Action Plan (CAP) addressing how the performance requirements will be met. ~~The Corrective Action Plan~~ CAP shall:

- 7.1.** List System deficiencies and the associated actions needed to achieve required System performance. Examples of such actions include:
  - Installation, modification, retirement, or removal of Transmission and generation Facilities and any associated equipment.
  - Installation, modification, or removal of Protection Systems or ~~Special Protection Systems~~ Remedial Action Schemes.
  - Use of Operating Procedures, specifying how long they will be needed as part of the ~~Corrective Action Plan~~ CAP.
  - Use of Demand-Side Management, new technologies, or other initiatives.
- 7.2.** ~~Be reviewed in subsequent~~ developed within one year of completion of the benchmark GMD Vulnerability Assessments until it is determined that the System meets the performance requirements contained in Table 1.
- 7.3.** Include a timetable, subject to revision by the responsible entity in Part 7.4, for implementing the selected actions from Part 7.1. The timetable shall:
  - 7.3.1.** Specify implementation of non-hardware mitigation, if any, within two years of development of the CAP; and
  - 7.3.2.** Specify implementation of hardware mitigation, if any, within four years of development of the CAP.

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<sup>43</sup> Order No. 830 at PP 101-102.

- 7.4.** Be revised if situations beyond the control of the responsible entity determined in Requirement R1 prevent implementation of the CAP within the timetable for implementation provided in Part 7.3. The revised CAP shall document the following, and be updated at least once every 12 calendar months until implemented:
- 7.4.1.** Circumstances causing the delay for fully or partially implementing the selected actions in Part 7.1;
- 7.4.2.** Description of the original CAP, and any previous changes to the CAP, with the associated timetable(s) for implementing the selected actions in Part 7.1; and
- 7.4.3.** Revisions to the selected actions in Part 7.1, if any, including utilization of Operating Procedures if applicable, and the updated timetable for implementing the selected actions.
- 7.37.5.** Be provided ~~within 90 calendar days of completion:~~ (i) to the responsible entity's Reliability Coordinator, adjacent Planning Coordinator(s), adjacent Transmission Planner(s), and functional entities referenced in the Corrective Action Plan CAP within 90 calendar days of development or revision, and (ii) to any functional entity that submits a written request and has a reliability-related need within 90 calendar days of receipt of such request or within 90 calendar days of development or revision, whichever is later.
- 7.3.17.5.1.** If a recipient of the ~~Corrective Action Plan~~ CAP provides documented comments on the results, the responsible entity shall provide a documented response to that recipient within 90 calendar days of receipt of those comments.

Revised Requirement R7 Part 7.2 would require responsible entities to develop a Corrective Action Plan within one year of the benchmark GMD Vulnerability Assessment, if the entity concludes that its System does not meet the performance requirements for the steady state planning benchmark GMD event. Under new Requirement R7 Part 7.3, the Corrective Action Plan shall include a timeline that specifies the completion of non-hardware and hardware mitigation within two and four years of development of the Corrective Action Plan, respectively.

In accordance with the Commission's directive, the proposed standard requires entities to take prompt action to address any vulnerabilities they identify in their systems. The proposed standard recognizes, however, that there may be circumstances outside of an entity's control that could prevent the completion of a mitigation activity by the specified timetable. Such events

could include, for example: delays due to the regulatory or legal processes, such as permitting; delays from stakeholder processes required by tariffs; delays resulting from equipment lead times; or delays resulting from the inability to acquire necessary right-of-way. In such circumstances, an entity may maintain compliance with the standard by revising its Corrective Action Plan in accordance with Requirement R7 Part 7.4.

Under Part 7.4, the entity shall revise its Corrective Action Plan if events beyond its control prevent implementation of the Corrective Action Plan within the original timetable. In the revised Corrective Action Plan, the responsible entity must provide justification for its revised timetable by documenting: (1) the circumstances causing the delay; (2) description of the original Corrective Action Plan and any changes; and (3) revisions to selected actions, including the use of any operating procedures if applicable, along with an updated timetable for completion. The revised Corrective Action Plan shall be updated at least annually. The responsible entity must then provide its revised Corrective Action Plan to recipients of the original Corrective Action Plan (i.e., Reliability Coordinator, adjacent Planning Coordinator(s), adjacent Transmission Planner(s), functional entities referenced in the Corrective Action Plan, and any functional entity that submits a written request and has a reliability related need for the information.) Thus, Requirement R7 would implement the Commission directed deadlines for Corrective Action Plans and mitigation, along with a process to maintain accountability and communication with affected entities when circumstances beyond a responsible entity's control affect the entity's ability to complete implementation within the original deadlines.

This approach is consistent with other Commission-approved Reliability Standards. For example, Reliability Standard FAC-003-4 Requirement R7 provides that an entity may modify its annual vegetation work plan in light of circumstances beyond the entity's control, such as a

natural disaster or other circumstance. (FAC-003-4 Requirement R7 also specifies other acceptable reasons for modifying an annual work plan, including permitting delays.) Reliability Standard PRC-004-5(i) Requirement R5 states that a responsible entity that owns a Protection System component that caused a Misoperation shall either develop a Corrective Action Plan or explain in a declaration why corrective actions are beyond the entity's control or would not improve reliability. In light of the potential planning, siting, budgeting approval, and regulatory uncertainties associated with transmission projects that are outside of an entity's control, it is appropriate to include such a flexible approach to GMD Corrective Action Plan deadlines in proposed TPL-007-2.

As noted above, proposed Requirement R7 continues to apply only where an entity has identified system performance issues through the benchmark GMD Vulnerability Assessment. Mitigation considerations for vulnerabilities identified through the supplemental GMD Vulnerability Assessment are addressed in proposed Requirement R8 Part 8.3. Under this Part, if a responsible entity concludes that there would be Cascading caused by the supplemental GMD event, the entity shall conduct an analysis of possible actions to reduce the likelihood or mitigate the impacts of the event.

The standard drafting team determined that requiring formal Corrective Action Plans based on assessments of the supplemental GMD event would not be appropriate at this time. As discussed in the Supplemental GMD Event Description white paper, the supplemental GMD event is based on a small number of observed localized enhanced geoelectric field events that provide only general insight into the geographic size of localized events during severe solar storms. Additionally, currently available modeling tools do not provide entities with capabilities to model localized enhancements within a severe GMD event realistically. As a result, entities

may need to employ conservative approaches when performing the supplemental GMD Vulnerability Assessment, such as applying the localized peak geoelectric field over an entire planning area. For these reasons, requiring mandatory mitigation may not provide effective reliability benefit or use resources optimally. The approach used in the proposed standard for the supplemental GMD event provides entities with flexibility to consider and select mitigation actions based on their circumstances and is similar to the approach used in Reliability Standard TPL-001-4 Requirement R3 Part 3.5 for extreme events.

**E. Enforceability of Proposed Reliability Standard TPL-007-2**

Proposed Reliability Standard TPL-007-2 includes Measures in support of each Requirement to ensure that Requirements are enforced in a clear, consistent, non-preferential manner, without prejudice to any party. The proposed standard also includes VRFs and VSLs for each Requirement, which are used to help determine appropriate sanctions if an applicable entity violates a Requirement. VRFs assess the impact to reliability of violating a specific Requirement, while VSLs provide guidance on the way that NERC will enforce Requirements.

The proposed standard includes the same VRFs and VSLs for Requirements R1 through R7, which were approved by the Commission in Order No. 830. Proposed Requirement R8 would apply a High VRF; proposed Requirements R9 and R10 would apply a Medium VRF; and Requirements R11 and R12 would apply a Lower VRF. Proposed Requirements R8 through R10 would also apply a graduated scale of Lower to Severe VSLs (depending on the extent of the violation), while proposed Requirements R11 and R12 would only apply a Severe VSL in recognition of the binary nature of compliance with the data obligations.

These VRFs and VSLs comport with NERC and Commission guidelines. The High VRF proposed for Requirement R8 is consistent with both Reliability Standard TPL-001-4 (requiring

an annual planning assessment) and Reliability Standard TPL-007-1 Requirement R4. Further failure to complete a supplemental GMD Vulnerability Assessment could, under certain conditions, place the BES at unacceptable risk. The Medium VRF proposed for Requirements R9 and R10 is similarly consistent with TPL-007-1 Requirements R5 and R6, which require responsible entities to provide GIC data to Transmission Owners and Generator Owners for assessments. In addition, failure to provide GIC flow information or conduct a supplemental transformer impact assessment is unlikely to lead to BES instability, separation, or cascading. The Lower VRF proposed for Requirements R11 and R12 is also consistent with other standards, such as the data collection related obligations in Reliability Standards MOD-032-1 Requirement R1 and IRO-010-2 Requirement R1. Finally, a Lower VRF for both Requirement R11 and R12 would also be appropriate, as an entity's failure to follow its process to obtain GIC monitor or geomagnetic field data would not be expected to adversely affect the electrical state or capability of the BES, or the ability to effectively monitor, control, or restore the BES. Please see Exhibit C for more detailed analysis of the proposed VRFs and VSLs.

## **V. EFFECTIVE DATE**

NERC respectfully requests that the Commission approve NERC's proposed implementation plan, attached to this Petition as Exhibit B. Under this plan, proposed Reliability Standard TPL-007-2 would become effective on the first day of the first calendar quarter that is three months after Commission approval. NERC requests retirement of Reliability Standard TPL-007-1 immediately prior to the effective date of TPL-007-2.

The proposed TPL-007-2 implementation plan recognizes that several Requirements in TPL-007-1 are or will soon become effective, and that many entities may now be taking steps to complete the studies or assessments required by other Requirements in TPL-007-1 that will become enforceable in the future. The proposed implementation plan thus contains two phased

compliance timelines depending on whether proposed Reliability Standard TPL-007-2 standard becomes effective before January 1, 2021 or on/after January 1, 2021:<sup>44</sup>

- If the proposed standard becomes effective before **January 1, 2021**, a new phased compliance schedule would support entities completing Requirements for the supplemental GMD Vulnerability Assessment concurrently with Requirements for the benchmark GMD Vulnerability Assessment.<sup>45</sup>
- If the standard becomes effective on or after **January 1, 2021**, entities would continue work on benchmark GMD Vulnerability Assessments and complete supplemental GMD Vulnerability Assessments during the next assessment cycle.

Under either timeline, entities would be required to comply with Requirements for the collection of GMD monitoring data within 24 months of the effective date of the standard. The phased-in compliance dates provided in the proposed implementation plan appropriately balance the reliability need to implement the new and revised Requirements while providing entities with sufficient time to meet their obligations.

## **VI. UPDATE ON NERC'S ONGOING GMD RESEARCH WORK PLAN AND SECTION 1600 GMD DATA REQUEST ACTIVITIES**

As noted earlier in this Petition, NERC is continuing work to address the Commission's GMD research and data collection directives from Order No. 830. On May 30, 2017, NERC submitted a preliminary version of its GMD Research Work Plan in Docket No. RM15-11-002 describing how NERC would oversee research into the specific GMD topics of interest identified by the Commission.<sup>46</sup> NERC is working with the Electric Power Research Institute ("EPRI") to

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<sup>44</sup> Under the TPL-007-1 implementation plan, this is the date by which entities would be required to comply with TPL-007-1 Requirement R6 pertaining to transformer thermal impact assessments based on the benchmark GMD event.

<sup>45</sup> Depending on the date of Commission approval of TPL-007-2, the phased compliance dates for completing steps for both benchmark and supplemental GMD Vulnerability Assessments may be slightly delayed from the dates set forth for benchmark GMD Vulnerability Assessments under the TPL-007-1 implementation plan.

<sup>46</sup> *Geomagnetic Disturbance Research Work Plan of the North American Electric Reliability Corporation*, Docket No. RM15-11-002 (May 30, 2017).

prepare an updated GMD Research Work Plan to submit to the Commission by April 2018 in accordance with the Commission's October 19, 2017 Order.<sup>47</sup> NERC and EPRI initiated the GMD Research Work plan in November 2017 through an EPRI project that is supported by utility and Independent System Operator participants and involves NERC GMD Task Force, U.S. national laboratories, equipment manufacturers, and other North American research partners.

To address the Commission's Order No. 830 data collection directive, NERC recently prepared an initial draft Request for Data or Information under Section 1600 of the NERC Rules of Procedure. The draft was prepared in conjunction with the NERC GMD Task Force under the oversight of the NERC Planning Committee. In accordance with the NERC Rules of Procedure, NERC provided the initial draft to Commission's Office of Electric Reliability on January 8, 2018. NERC expects to post the draft request for a 45-day public comment period on or around January 30, 2018. Following the close of this comment period, NERC will review the comments received and revise the draft Section 1600 GMD Data Request as appropriate. NERC will also continue work to develop the necessary information technology infrastructure and data reporting specifications to facilitate the collection of GMD data. NERC intends to seek authorization from the NERC Board of Trustees to issue the Section 1600 GMD Data Request in August 2018.

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<sup>47</sup> *Order on GMD Research Work Plan*, 161 FERC ¶ 61,048 (Oct. 19, 2017) (accepting NERC's preliminary GMD Research Work Plan).

## VII. CONCLUSION

For the reasons set forth above, NERC respectfully requests that the Commission approve proposed Reliability Standard TPL-007-2 and related elements, the proposed implementation plan, and the retirement of currently-effective Reliability Standard TPL-007-1 as discussed herein.

Respectfully submitted,

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