

165 FERC ¶ 61,124
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

18 CFR Part 40

[Docket Nos. RM18-8-000 and RM15-11-003; Order No. 851]

Geomagnetic Disturbance Reliability Standard; Reliability Standard for Transmission System Planned Performance for Geomagnetic Disturbance Events

(Issued November 15, 2018)

AGENCY: Federal Energy Regulatory Commission.

ACTION: Final rule.

SUMMARY: The Federal Energy Regulatory Commission (Commission) approves Reliability Standard TPL-007-2 (Transmission System Planned Performance for Geomagnetic Disturbance Events). The North American Electric Reliability Corporation (NERC), the Commission-certified Electric Reliability Organization, submitted Reliability Standard TPL-007-2 for Commission approval. The Commission also directs NERC to develop and submit modifications to Reliability Standard TPL-007-2: (1) to require the development and implementation of corrective action plans to mitigate assessed supplemental GMD event vulnerabilities; and (2) to authorize extensions of time to implement corrective action plans on a case-by-case basis. In addition, the Commission accepts the revised GMD research work plan submitted by NERC.

EFFECTIVE DATE: This rule will become effective **[INSERT DATE 60 days after publication in the FEDERAL REGISTER]**.

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SUPPLEMENTARY INFORMATION:

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Before Commissioners: Neil Chatterjee, Chairman;
Cheryl A. LaFleur and Richard Glick.

Geomagnetic Disturbance Reliability Standard

Docket Nos. RM18-8-000

Reliability Standard for Transmission System Planned
Performance for Geomagnetic Disturbance Events

RM15-11-003

ORDER NO. 851

FINAL RULE

(Issued November 15, 2018)

1. Pursuant to section 215 of the Federal Power Act (FPA), the Commission approves Reliability Standard TPL-007-2 (Transmission System Planned Performance for Geomagnetic Disturbance Events).¹ The North American Electric Reliability Corporation (NERC), the Commission-certified Electric Reliability Organization (ERO), submitted Reliability Standard TPL-007-2 for Commission approval in response to directives in Order No. 830.² As discussed in this final rule, we determine that Reliability Standard TPL-007-2 better addresses the risks posed by geomagnetic

¹ 16 U.S.C. 824o.

² *Reliability Standard for Transmission System Planned Performance for Geomagnetic Disturbance Events*, Order No. 830, 156 FERC ¶ 61,215, (2016) *reh'g denied*, Order No. 830-A, 158 FERC ¶ 61,041 (2017).

disturbances (GMDs) to the Bulk-Power System, particularly with respect to the potential impacts of locally-enhanced GMD events, than currently-effective Reliability Standard TPL-007-1 and complies with the Commission's directives in Order No. 830.

2. GMD events occur when the sun ejects charged particles that interact with and cause changes in the earth's magnetic fields. GMD events have the potential to cause severe, wide-spread impacts on the Bulk-Power System.³ Currently-effective Reliability Standard TPL-007-1 requires applicable entities to assess the vulnerability of their transmission systems to a "benchmark GMD event." An applicable entity that does not meet certain performance requirements, based on the results of the benchmark GMD vulnerability assessment, must develop and implement a corrective action plan to achieve the performance requirements.

3. The improvements in Reliability Standard TPL-007-2 are responsive to the directives in Order No. 830: (1) to revise the benchmark GMD event definition, as it pertains to the required GMD vulnerability assessments and transformer thermal impact assessments, so that the definition is not based solely on spatially-averaged data; (2) to require the collection of necessary geomagnetically induced current (GIC) monitoring and magnetometer data; and (3) to include a one-year deadline for the completion of corrective action plans and two- and four-year deadlines to complete mitigation actions

³ *Reliability Standards for Geomagnetic Disturbances*, Order No. 779, 143 FERC ¶ 61,147, at P 3, *reh'g denied*, 144 FERC ¶ 61,113 (2013); *see also* Reliability Standard TPL-007-2, Background.

involving non-hardware and hardware mitigation.⁴ As discussed below, Reliability Standard TPL-007-2 complies with these directives and improves upon the currently-effective version of the Reliability Standard by requiring applicable entities to:

(1) in addition to the benchmark GMD event requirements, conduct supplemental GMD vulnerability assessments and thermal impact assessments, which apply a new supplemental GMD event definition that does not rely solely on spatially-averaged data; (2) obtain GIC and magnetometer data; and (3) meet the Commission-directed deadlines for the development and completion of tasks in corrective action plans. Accordingly, pursuant to section 215(d)(2) of the FPA, we approve Reliability Standard TPL-007-2.⁵

4. In addition, as discussed in the Notice of Proposed Rulemaking, we determine that it is appropriate, pursuant to section 215(d)(5) of the FPA,⁶ to direct NERC to develop and submit modifications to Reliability Standard TPL-007-2 to require the development and completion of corrective action plans to mitigate assessed supplemental GMD event vulnerabilities.⁷ As discussed below, requiring corrective action plans for supplemental GMD event vulnerabilities is appropriate to ensure the reliability of the Bulk-Power

⁴ “Spatial averaging” refers to the averaging of magnetometer readings over a geographic area. In developing the benchmark GMD event definition, the standard drafting team averaged several (but not all) geomagnetic field readings taken by magnetometers located within square geographical areas of 500 km per side.

⁵ 16 U.S.C. 824o(d)(2).

⁶ *Id.* 824o(d)(5).

⁷ *Geomagnetic Disturbance Reliability Standard*, Notice of Proposed Rulemaking, 83 FR 23854 (May 23, 2018), 163 FERC ¶ 61,126 (2018) (NOPR).

System when confronted with locally-enhanced GMD events, just as corrective action plans are necessary to mitigate the effects of benchmark GMD events. Based on the record in this proceeding, we discern no technical barriers to either developing or complying with such a requirement. Moreover, the record supports issuance of a directive at this time notwithstanding comments in response to the NOPR advocating postponement of any directive until after the completion of additional GMD research. As discussed below, the relevant GMD research tasks are scheduled to be completed before the modified Reliability Standard must be submitted. The Commission directs NERC to submit the modified Reliability Standard for approval within 12 months from the effective date of Reliability Standard TPL-007-2.

5. We also determine that it is appropriate, pursuant to section 215(d)(5) of the FPA, to direct that NERC modify the provision in Reliability Standard TPL-007-2, Requirement R7.4 that allows applicable entities to exceed deadlines for completing corrective action plan tasks when “situations beyond the control of the responsible entity [arise].” The NOPR raised concerns regarding the appropriateness of a self-executing deadline extension and observed that it was inconsistent with guidance in Order No. 830 that extension requests be considered on a case-by-case basis.⁸ We recognize the point made in NERC’s comments in response to the NOPR that, under NERC’s proposal, “NERC and Regional Entity staff would exercise their authority to review the reasonableness of any Corrective Action Plan delay, including reviewing the ‘situations

⁸ Order No. 830, 156 FERC ¶ 61,215 at P 102.

beyond the control of the responsible entity’ that are cited as causing the delay” and that Requirement R7.4 is “not so flexible ... as to allow entities to extend Corrective Action Plan deadlines indefinitely or for any reason whatsoever.”⁹ While we generally agree with the standard of review that NERC states it will use to assess the merits of extension requests, we conclude that such assessments should be made before any time extensions are permitted. By requiring prior approval of extension requests, the modified Reliability Standard will limit the potential for unwarranted delays in implementing corrective action plans while also providing NERC with an advance and more holistic understanding of where, to whom, and for how long, extensions are granted. We expect that the extension process developed by NERC in response to our directive will be timely and efficient such that applicable entities will receive prompt responses after submitting to NERC or a Regional Entity, as appropriate, the extension request and associated information described in Requirement R7.4.¹⁰ We also direct NERC, as proposed in the NOPR, to prepare and submit a report addressing how often and why applicable entities are exceeding corrective action plan deadlines as well as the disposition of extension requests, which is due within 12 months from the date on which applicable entities must comply with the last requirement of Reliability Standard TPL-007-2. Following receipt of the report, the Commission will determine whether further action is necessary.

⁹ NERC Comments at 20-21.

¹⁰ NOPR, 163 FERC ¶ 61,126 at P 50.

6. The Commission, as discussed below, also accepts the revised GMD research work plan submitted by NERC on April 19, 2018.¹¹

I. Background

A. Section 215 and Mandatory Reliability Standards

7. Section 215 of the FPA requires the Commission to certify an ERO to develop mandatory and enforceable Reliability Standards, subject to Commission review and approval. Once approved, the Reliability Standards may be enforced in the United States by the ERO, subject to Commission oversight, or by the Commission independently.¹²

B. GMD Primer

8. GMD events occur when the sun ejects charged particles that interact and cause changes in the earth's magnetic fields.¹³ Once a solar particle is ejected, it can take between 17 to 96 hours (depending on its energy level) to reach earth.¹⁴ A geoelectric field is the electric potential (measured in volts per kilometer (V/km)) on the earth's surface and is directly related to the rate of change of the magnetic fields.¹⁵ The geoelectric field has an amplitude and direction and acts as a voltage source that can

¹¹ North American Electric Reliability Corporation, Filing, Docket No. RM15-11-003 (filed Apr. 19, 2018) (Revised GMD Research Work Plan).

¹² 16 U.S.C. 824o(e).

¹³ See NERC, 2012 Special Reliability Assessment Interim Report: Effects of Geomagnetic Disturbances on the Bulk Power System at i-ii (February 2012).

¹⁴ *Id.* at ii.

¹⁵ *Id.*

cause GICs to flow on long conductors, such as transmission lines.¹⁶ The magnitude of the geoelectric field amplitude is impacted by local factors such as geomagnetic latitude and local earth conductivity.¹⁷ Geomagnetic latitude is the proximity to earth's magnetic north and south poles, as opposed to earth's geographic poles.¹⁸ Local earth conductivity is the ability of the earth's crust to conduct electricity at a certain location to depths of hundreds of kilometers down to the earth's mantle. Local earth conductivity impacts the magnitude (i.e., severity) of the geoelectric fields that are formed during a GMD event by, all else being equal, a lower earth conductivity resulting in higher geoelectric fields.¹⁹

9. GICs can flow in an electric power system with varying intensity depending on the various factors discussed above. As explained in the Background section of Reliability Standard TPL-007-2, “[d]uring a GMD event, geomagnetically-induced currents (GIC) may cause transformer hot-spot heating or damage, loss of Reactive Power sources, increased Reactive Power demand, and Misoperation(s), the combination of which may result in voltage collapse and blackout.”

¹⁶ *Id.*

¹⁷ NERC, Benchmark Geomagnetic Disturbance Event Description, Docket No. 15-11-000, at 4 (filed June 28, 2016) (2016 NERC White Paper).

¹⁸ *Id.*

¹⁹ *Id.*

C. Currently-Effective Reliability Standard TPL-007-1 and Order No. 830

1. Currently-Effective Reliability Standard TPL-007-1

10. Reliability Standard TPL-007-1 consists of seven requirements and applies to planning coordinators, transmission planners, transmission owners and generation owners who own or whose planning coordinator area or transmission planning area includes a power transformer with a high side, wye-grounded winding connected at 200 kV or higher.

11. Requirement R1 requires planning coordinators and transmission planners (i.e., “responsible entities”) to determine the individual and joint responsibilities in the planning coordinator’s planning area for maintaining models and performing studies needed to complete the GMD vulnerability assessment required in Requirement R4. Requirement R2 requires responsible entities to maintain system models and GIC system models needed to complete the GMD vulnerability assessment required in Requirement R4. Requirement R3 requires each responsible entity to have criteria for acceptable system steady state voltage performance for its system during the GMD conditions described in Attachment 1 of Reliability Standard TPL-007-1. Requirement R4 requires responsible entities to conduct a GMD vulnerability assessment every 60 months using the benchmark GMD event described in Attachment 1. Requirement R5 requires responsible entities to provide GIC flow information, based on the benchmark GMD event definition, to be used in the transformer thermal impact assessments required in Requirement R6, to each transmission owner and generator owner that owns an applicable transformer within the applicable planning area. Requirement R6 requires

transmission owners and generator owners to conduct thermal impact assessments on solely and jointly owned applicable transformers where the maximum effective GIC value provided in Requirement R5 is 75 Amperes per phase (A/phase) or greater.

Requirement R7 requires responsible entities to develop corrective action plans if the GMD vulnerability assessment concludes that the system does not meet the performance requirements in Table 1 of Reliability Standard TPL-007-1.

12. Calculation of the benchmark GMD event, against which applicable entities must assess their facilities, is fundamental to compliance with Reliability Standard TPL-007-1. Reliability Standard TPL-007-1, Requirement R3 states that “[e]ach responsible entity, as determined in Requirement R1, shall have criteria for acceptable System steady state voltage performance for its System during the benchmark GMD event described in Attachment 1.”

13. Reliability Standard TPL-007-1, Attachment 1 states that the benchmark GMD event is composed of four elements: (1) a reference peak geoelectric field amplitude of 8 V/km derived from statistical analysis of historical magnetometer data; (2) a scaling factor to account for local geomagnetic latitude; (3) a scaling factor to account for local earth conductivity; and (4) a reference geomagnetic field time series or wave shape to facilitate time-domain analysis of GMD impact on equipment. The product of the first three elements is referred to as the regional peak geoelectric field amplitude. The benchmark GMD event defines the geoelectric field values used to compute GIC flows

for a GMD vulnerability assessment, which is required in Reliability Standard TPL-007-1.²⁰

14. For the purpose of determining a benchmark event that specifies what severity GMD events a responsible entity must assess for potential impacts on the Bulk-Power System, NERC determined that a 1-in-100 year GMD event would cause an 8 V/km reference peak geoelectric field amplitude at 60 degree north geomagnetic latitude using Québec's earth conductivity.²¹ Scaling factors (i.e., multiplying values) are applied to this reference peak geoelectric field amplitude to adjust the 8 V/km value for different geomagnetic latitudes (scaling factors between 0.1 and 1.0) and earth conductivities (scaling factors between 0.21 and 1.17). NERC identified a reference geomagnetic field time series from an Ottawa, Ontario magnetic observatory during a 1989 GMD storm affecting Québec. NERC used this to estimate a time series (i.e., 10-second values over a period of days) of the geoelectric field that is representative of what is expected to occur at 60 degree geomagnetic latitude during a 1-in-100 year GMD event. Such a time series

²⁰ See Reliability Standard TPL-007-1, Requirements R4 and R5. Reliability Standard TPL-007-1 does not set a threshold amount of GIC flow that would constitute a vulnerable transformer. However, if a transformer is calculated to experience a maximum effective GIC flow during a benchmark GMD event of a least 75 A/phase, a thermal impact assessment of that transformer is required. See Reliability Standard TPL-007-1, Requirement R6.

²¹ NERC used Québec as the location for the reference peak 1-in-100 year GMD event because of its proximity to 60 degree geomagnetic latitude and its well understood earth model. By creating scaling factors, each entity can scale this reference peak geoelectric field and geoelectric field time series values to match its own expected field conditions.

is used in some methods of calculating the vulnerability of a transformer to damage from heating caused by GIC.

15. NERC used field measurements taken from the International Monitor for Auroral Geomagnetic Effects (IMAGE) magnetometer chain, which consists of 39 magnetometer stations in Northern Europe, for the period 1993-2013 to calculate the reference peak geoelectric field amplitude. As described in the 2016 NERC White Paper, to arrive at a reference peak geoelectric field amplitude of 8 V/km, NERC “spatially averaged” four different station groups each spanning a square area of approximately 500 km (roughly 310 miles) in width.

2. Order No. 830

16. On January 21, 2015, NERC submitted for Commission approval Reliability Standard TPL-007-1 in response to the directive in Order No. 779 that NERC develop one or more Reliability Standards to address the effects of GMD events on the electric grid.²² In Order No. 830, the Commission approved Reliability Standard TPL-007-1, concluding that Reliability Standard TPL-007-1 addressed the Commission’s directive by requiring applicable Bulk-Power System owners and operators to conduct, on a recurring five-year cycle, initial and ongoing vulnerability assessments regarding the potential impact of a benchmark GMD event on the Bulk-Power System as a whole and on Bulk-Power System components. In addition, the Commission determined that Reliability Standard TPL-007-1 requires applicable entities to develop and implement corrective

²² Order No. 779, 144 FERC ¶ 61,113 at P 54.

action plans to mitigate vulnerabilities identified through those recurring vulnerability assessments and that potential mitigation strategies identified in Reliability Standard TPL-007-1 include, but are not limited to, the installation, modification or removal of transmission and generation facilities and associated equipment.

17. In Order No. 830, the Commission also determined that Reliability Standard TPL-007-1 should be modified. Specifically, Order No. 830 directed NERC to develop and submit modifications to Reliability Standard TPL-007-1 concerning: (1) the calculation of the reference peak geoelectric field amplitude component of the benchmark GMD event definition; (2) the collection and public availability of necessary GIC monitoring and magnetometer data; and (3) deadlines for completing corrective action plans and the mitigation measures called for in corrective action plans. Order No. 830 directed NERC to develop and submit these revisions for Commission approval within 18 months of the effective date of Order No. 830.

18. With respect to the calculation of the reference peak geoelectric field amplitude component of the benchmark GMD event definition, Order No. 830 expressed concern with relying solely on spatial averaging in Reliability Standard TPL-007-1 because “the use of spatial averaging in this context is new, and thus there is a dearth of information or research regarding its application or appropriate scale.”²³ While Order No. 830 directed that the peak geoelectric field amplitude should not be based solely on spatially-averaged

²³ Order No. 830, 156 FERC ¶ 61,215 at P 45.

data, the Commission indicated that this “directive should not be construed to prohibit the use of spatial averaging in some capacity, particularly if more research results in a better understanding of how spatial averaging can be used to reflect actual GMD events.”²⁴

D. NERC Petition and Reliability Standard TPL-007-2

19. NERC states that Reliability Standard TPL-007-2 enhances currently-effective Reliability Standard TPL-007-1 by addressing reliability risks posed by GMDs more effectively and implementing the directives in Order No. 830.²⁵ NERC asserts that Reliability Standard TPL-007-2 reflects the latest in GMD understanding and provides a technically sound and flexible approach to addressing the concerns discussed in Order No. 830. NERC contends that the proposed modifications enhance reliability by expanding GMD vulnerability assessments to include severe, localized impacts and by implementing deadlines and processes to maintain accountability in the development, completion, and revision of corrective action plans developed to address identified vulnerabilities. Further, NERC states that the proposed modifications improve the availability of GMD monitoring data that may be used to inform GMD vulnerability assessments.

20. Reliability Standard TPL-007-2 modifies currently-effective Reliability Standard TPL-007-1 by requiring applicable entities to: (1) conduct supplemental GMD

²⁴ *Id.* P 46.

²⁵ Reliability Standard TPL-007-2 is not attached to this final rule. Reliability Standard TPL-007-2 is available on the Commission’s eLibrary document retrieval system in Docket No. RM18-8-000 and on the NERC website, www.nerc.com.

vulnerability and transformer thermal impact assessments in addition to the existing benchmark GMD vulnerability and transformer thermal impact assessments required in Reliability Standard TPL-007-1; (2) collect data from GIC monitors and magnetometers as necessary to enable model validation and situational awareness; and (3) develop necessary corrective action plans within one year from the completion of the benchmark 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.²⁶

21. In particular, Reliability Standard TPL-007-2 modifies Requirements R1 (identification of responsibilities), R2 (system and GIC system models) and R3 (criteria for acceptable System steady state) to extend the existing requirements pertaining to benchmark GMD assessments to the new supplemental GMD assessments. Reliability Standard TPL-007-2 adds the newly mandated supplemental GMD vulnerability and transformer thermal impact assessments in new Requirements R8 (supplemental GMD vulnerability assessment), R9 (GIC flow information needed for supplemental GMD thermal impact assessments) and R10 (supplemental GMD thermal impact assessments). The supplemental GMD event definition contains a higher, non-spatially-averaged reference peak geoelectric field amplitude component than the benchmark GMD event

²⁶ Unless otherwise indicated, the requirements of Reliability Standard TPL-007-2 are substantively the same as the requirements in currently-effective Reliability Standard TPL-007-1.

definition (12 V/km versus 8 V/km). These three new requirements largely mirror existing Requirements R4, R5, and R6 that currently apply, and continue to apply, only to benchmark GMD vulnerability and transformer thermal impact assessments.²⁷

22. In addition, Reliability Standard TPL-007-2 includes two other new requirements, Requirements R11 and R12, that require applicable entities to gather GIC monitoring data (Requirement R11) and magnetometer data (Requirement R12).

23. Reliability Standard TPL-007-2 modifies existing Requirement R7 (corrective action plans) to create a one-year deadline for the development of corrective action plans and two and four-year deadlines to complete actions involving non-hardware and hardware mitigation, respectively, for vulnerabilities identified in the benchmark GMD assessment. The modifications to Requirement R7 include a provision allowing for extension of deadlines if “situations beyond the control of the responsible entity determined in Requirement R1 prevent implementation of the [corrective action plan] within the timetable for implementation.”

E. NOPR

24. On May 17, 2018, the Commission issued a NOPR that proposed to approve Reliability Standard TPL-007-2 as the Reliability Standard largely addresses the directives in Order No. 830. However, the NOPR identified two aspects of Reliability

²⁷ An exception is the qualifying threshold for transformers required to undergo thermal impact assessments: for the supplemental GMD assessment the qualifying threshold for transformers is a maximum effective GIC value of 85 A/phase while the threshold for benchmark GMD event assessments is 75 A/phase.

Standard TPL-007-2 that are inconsistent with Order No. 830: (1) the lack of any requirement to develop and implement corrective action plans in response to assessed supplemental GMD event vulnerabilities; and (2) a general allowance, per proposed Requirement R7.4, of extensions of time to complete corrective action plans as opposed to permitting extensions of time on a case-by-case basis.

25. Having identified these issues, the NOPR proposed to direct NERC, pursuant to section 215(d)(5) of the FPA, to develop and submit modifications to Reliability Standard TPL-007-2 to require applicable entities to develop and implement corrective action plans to mitigate vulnerabilities discovered through supplemental GMD vulnerability assessments. The NOPR proposed to direct NERC to submit the modified Reliability Standard for approval within 12 months from the effective date of Reliability Standard TPL-007-2. The NOPR also sought comment on two options for addressing the Commission's concerns regarding the potential for undue delay of mitigation because of the proposed time-extension process in Requirement R7.4: (1) direct NERC to bring Reliability Standard TPL-007-2 into alignment with Order No. 830 through a process whereby NERC or Regional Entities consider extensions on a case-by-case basis using the information that must be submitted under Requirement R7.4; or (2) approve the proposed provision without directing modifications. Under either option, NERC would prepare and submit a report regarding how often and why applicable entities are

exceeding corrective action plan deadlines following implementation of Reliability Standard TPL-007-2.²⁸

26. The Commission received NOPR comments from nine entities. We address below the issues raised in the NOPR and comments as well as NERC's revised GMD research work plan and the comments submitted in response. The Appendix to this final rule lists the entities that filed comments in both matters.

II. Discussion

27. Pursuant to section 215(d)(2) of the FPA, the Commission approves Reliability Standard TPL-007-2 as just, reasonable, not unduly discriminatory or preferential, and in the public interest. We conclude that Reliability Standard TPL-007-2 is an improvement over currently-effective Reliability Standard TPL-007-1 and responds to the directives in Order No. 830: (1) to revise the benchmark GMD event definition, as it pertains to the required GMD Vulnerability Assessments and transformer thermal impact assessments, so that the definition is not based solely on spatially-averaged data; (2) to require the collection of necessary GIC monitoring and magnetometer data; and (3) to include a one-year deadline for the completion of corrective action plans and two and four-year deadlines to complete mitigation actions involving non-hardware and hardware mitigation, respectively.²⁹

²⁸ The NOPR proposed that the report, under the first option, would also include statistics describing how often extension requests were granted.

²⁹ In its petition, NERC stated that it would address the directive in Order No. 830 on the collection of GIC monitoring and magnetometer data through a forthcoming

28. Reliability Standard TPL-007-2 complies with the directives in Order No. 830 by requiring, in addition to the benchmark GMD event vulnerability and thermal impact assessments, supplemental GMD vulnerability and thermal impact assessments. The supplemental GMD event definition in Reliability Standard TPL-007-2 contains a non-spatially-averaged reference peak geoelectric field amplitude component of 12 V/km, in contrast to the 8 V/km figure in the spatially-averaged benchmark GMD event definition. As NERC explains in its petition, the supplemental GMD event will be used to “represent conditions associated with localized enhancement of the geomagnetic field during a severe GMD event for use in assessing GMD impacts.”³⁰ Reliability Standard TPL-007-2 therefore addresses the Commission’s directive to modify currently-effective Reliability Standard TPL-007-1 so that the benchmark GMD event does not rely solely on spatially-averaged data to calculate the reference peak geoelectric field amplitude.

29. As proposed in the NOPR, pursuant to section 215(d)(5) of the FPA, we also determine that it is appropriate to direct NERC to develop and submit modifications to Reliability Standard TPL-007-2 to require the development and completion of corrective action plans to mitigate assessed supplemental GMD event vulnerabilities. Given that

NERC data request to applicable entities pursuant to Section 1600 of the NERC Rules of Procedure rather than through a Reliability Standard requirement. NERC Petition at 27. On February 7, 2018, NERC released a draft data request for a 45-day comment period. The NERC Board of Trustees (BOT) subsequently approved the GMD data request at the August 2018 BOT meeting.

³⁰ NERC Petition at 12.

NERC has acknowledged the potential for “severe, localized impacts” associated with supplemental GMD event vulnerabilities, we see no basis for requiring corrective action plans for benchmark GMD events but not for supplemental GMD events.³¹ Based on the record in this proceeding, there appear to be no technical barriers to developing or complying with such a requirement. Moreover, as discussed below, the record supports issuance of a directive at this time, notwithstanding NOPR comments advocating postponement of any directive until after the completion of additional GMD research, because relevant GMD research is scheduled to be completed before the due date for submitting a modified Reliability Standard. The Commission therefore adopts the NOPR proposal and directs NERC to submit the modified Reliability Standard for approval within 12 months from the effective date of Reliability Standard TPL-007-2.

30. We also determine, pursuant to section 215(d)(5) of the FPA, that it is appropriate to direct that NERC develop further modifications to Reliability Standard TPL-007-2, Requirement R7.4. Under NERC’s proposal, applicable entities are allowed, without prior approval, to exceed deadlines for completing corrective action plan tasks when “situations beyond the control of the responsible entity [arise].”³² Instead, as discussed

³¹ NERC Petition at 4 (“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”).

³² In the Supplemental Material section of Reliability Standard TPL-007-2, examples of situations beyond the control of the of the responsible entity include, but are not limited to, delays resulting from regulatory/legal processes, such as permitting; delays

below, we direct NERC to develop a timely and efficient process, consistent with the Commission's guidance in Order No. 830, to consider time extension requests on a case-by-case basis. Our directive balances the availability of time extensions when applicable entities are presented with the types of uncontrollable delays identified in NERC's petition and NOPR comments with the need to ensure that the mitigation of known GMD vulnerabilities is not being improperly delayed through such requests. Further, as proposed in the NOPR, we direct NERC to prepare and submit a report addressing how often and why applicable entities are exceeding corrective action plan deadlines as well as the disposition of time extension requests. The report is due within 12 months from the date on which applicable entities must comply with the last requirement of Reliability Standard TPL-007-2. Following receipt of the report, the Commission will determine whether further action is necessary.

31. The Commission, as discussed below, also accepts the revised GMD research work plan submitted by NERC on April 19, 2018.

A. Corrective Action Plan for Supplemental GMD Event Vulnerabilities
NOPR

32. The NOPR proposed to determine that the absence of a requirement to mitigate assessed supplemental GMD event vulnerabilities is inconsistent with Order No. 830, and Order No. 779, because the proposal does not require "owners and operators [to] develop

resulting from stakeholder processes required by tariff; delays resulting from equipment lead times; or delays resulting from the inability to acquire necessary Right-of-Way.

and implement a plan to protect against instability, uncontrolled separation, or cascading failures of the Bulk-Power System.”³³

33. The NOPR explained that the Commission was not persuaded by NERC’s justification that technical limitations—specifically the small number of observations used to define the supplemental GMD event and the availability of modeling tools to assist entities in assessing vulnerabilities—make requiring mitigation premature at this time.³⁴ The NOPR, instead, accepted NERC’s statement that the supplemental GMD event definition “provides a technically justified method of assessing vulnerabilities to the localized peak effects of severe GMD events.”³⁵ The NOPR also observed that mitigation of supplemental GMD event vulnerabilities is appropriate because Reliability Standard TPL-007-2: (1) does not prescribe how applicable entities must perform such studies, and thus may incorporate any uncertainties regarding the geographic size of such events into their studies; (2) there are commercially-available tools that could allow for modeling of supplemental GMD events; and (3) other methods could be used within the framework of the Reliability Standard to study planning areas (e.g., superposition or sensitivity studies) in conjunction with other power system modeling tools. The NOPR further recognized that research tasks under way pursuant to the GMD research work

³³ NOPR, 163 FERC ¶ 61,126 at P 32.

³⁴ The Commission also rejected the assertion in NERC’s petition that an evaluation of possible actions for supplemental GMD events that result in Cascading is similar to the treatment of extreme events in Reliability Standard TPL-001-4 (Transmission System Planning Performance Requirements).

³⁵ NOPR, 163 FERC ¶ 61,126 at P 35 (quoting NERC Petition at 13).

plan that are relevant to the supplemental GMD event definition are scheduled to be completed in 2019 and the results of such research should inform the work of the standard drafting team.

Comments

34. NERC does not support the proposed directive. NERC maintains that the provision in Requirement R8.3 that requires applicable entities to evaluate possible actions designed to reduce the likelihood or mitigate the adverse impacts of a supplemental GMD event “is not merely advisory, but rather supports a range of potential mitigating actions, such as additional hardware mitigation, operating procedures, or other resilience actions to enhance recovery and restoration.”³⁶ NERC expounds on this by noting that the requirement to consider mitigation in Reliability Standard TPL-007-2 “would directly support mitigation that is required by [Reliability Standard EOP-010-1].”³⁷ NERC also contends that it “anticipates that the Corrective Action Plans, when needed to address performance requirements for the benchmark GMD event, will also provide a large degree of protection to the Bulk-Power System for events with locally-enhanced geomagnetic fields.”³⁸

35. NERC’s comments reiterate the rationale in its petition that requiring mitigation “would result in the de facto replacement of the benchmark GMD event with the

³⁶ NERC Comments at 9.

³⁷ *Id.* at 10.

³⁸ *Id.* at 11.

proposed supplemental GMD event.”³⁹ NERC maintains that “while the supplemental GMD event is strongly supported by data and analysis in ways that mirror the benchmark GMD event, there are aspects of it that are less definitive than the benchmark GMD event and less appropriate as the basis of requiring Corrective Action Plans.”⁴⁰ NERC also claims that the uncertainty of geographic size of the supplemental GMD event could not be addressed adequately by sensitivity analysis or through other methods because there are “inherent sources of modeling uncertainty (e.g., earth conductivity model, substation grounding grid resistance values, transformer thermal and magnetic response models) ... [and] introducing additional variables for sensitivity analysis, such as the size of the localized enhancement, may not improve the accuracy of GMD Vulnerability Assessments.”⁴¹ NERC further states that “commercially-available modeling tools now advertise capabilities that could be used to model localized GMD enhancements, [but] to NERC’s knowledge these capabilities have not been used extensively by planners, nor have the different software tools been benchmarked for consistency in results.”⁴²

36. NERC contends that completing the GMD work plan is a better alternative to the NOPR directive. Moreover, NERC states that it “commits to initiate a review of

³⁹ *Id.* at 11-12; *see also id.* at 14 (“many entities would likely employ the most conservative approach for conducting supplemental GMD Vulnerability Assessments, which would be to apply extreme peak values uniformly over an entire planning area”).

⁴⁰ *Id.* at 13.

⁴¹ *Id.* at 15.

⁴² *Id.*

TPL-007-2 following the completion of the GMD Research Work Plan to evaluate whether the standard continues to be supported by the available knowledge or whether additional refinements are necessary ... [which] could result in modifications to, or additional support for, the proposed supplemental GMD event, and thereby inform what the TPL-007 standard should require in terms of mitigation based on supplemental GMD Vulnerability Assessments.”⁴³ In response to the NOPR’s statement that the results of the GMD research work plan may inform the work of the standard drafting team tasked with carrying out the Commission’s proposed directive, NERC comments state that “it expects that the last of the project’s deliverables will be ready by early 2020 ... [but] [a]ny scientific research project schedule, however, must account for the possibility that additional time may be needed to explore potential findings or amend project approaches to provide more useful results.”⁴⁴ NERC states that while the technical report for Task 1 is scheduled to be completed by the fourth quarter of 2019 according to the revised GMD research work plan, NERC estimates that it will file a report with the Commission, after allowing a period of public comment, six months later (i.e., mid-2020).⁴⁵

⁴³ *Id.* at 18.

⁴⁴ *Id.* at 17.

⁴⁵ Revised GMD Research Work Plan at 5 (“NERC expects to submit [informational filings with the Commission] approximately six months following EPRI’s completion of the associated technical report(s)”; *id.*, Attachment 1 (Order No. 830 GMD Research Work Plan (April 2018)) at 7 (identifying “Q4 2019” as the estimated completion date of “Final technical report to provide additional technical support for the existing supplementary (localized) benchmark; or, propose update to the benchmark, as appropriate”).

37. Trade Associations, Idaho Power, NE ISO, TVA and BPA do not support the proposed directive. They contend that requiring corrective action plans for supplemental GMD event vulnerabilities: (1) may be premature given the limited data regarding localized GMD events; (2) would address low-probability events that are unlikely to affect a wide area; and (3) could impose costs on applicable entities that outweigh the potential benefits of such a directive. Like NERC, these commenters support completing the GMD research work plan before considering mandating corrective action plans for supplemental GMD event vulnerabilities. Idaho Power, moreover, contends that it would be better for registered entities to gain experience with corrective action plans for benchmark GMD events before mandating corrective action plans for supplemental GMD events. Trade Associations state that instead of the NOPR directive, any Commission directive should be limited to requiring NERC to develop “a study of the mitigation measures deployed and the effectiveness of these measures to mitigate benchmark GMD events before mandating mitigation measures on more localized events.”⁴⁶ Similarly, BPA maintains that instead of the NOPR directive, in order to assess the costs and benefits of requiring corrective action plans for supplemental GMD events, the Commission should require NERC to file periodic reports on supplemental GMD events and the possible actions to mitigate them.

⁴⁶ Trade Associations Comments at 12.

38. Resilient Societies and Reclamation support the NOPR directive. Reclamation states, and Resilient Societies concurs, that “[a]n exercise to only identify vulnerabilities arising from localized GMD events is not a cost-effective use of resources unless accompanied by activities to mitigate the identified vulnerabilities.”⁴⁷

Commission Determination

39. Pursuant to section 215(d)(5) of the FPA, the Commission adopts the NOPR proposal and directs NERC to develop and submit modifications to Reliability Standard TPL-007-2 to require corrective action plans for assessed supplemental GMD event vulnerabilities. While Reliability Standard TPL-007-2 requires applicable entities to assess supplemental GMD event vulnerabilities, it does not require corrective action plans to address assessed vulnerabilities. Instead, Reliability Standard TPL-007-2, Requirement R8.3 only requires applicable entities to make “an evaluation of possible actions to reduce the likelihood or mitigate the consequences and adverse impacts of the events if a supplemental GMD event is assessed to result in Cascading.” As the Commission observed in the NOPR, NERC’s proposal differs significantly from Order No. 830 because the intent of the directive was not only to identify vulnerabilities arising from localized GMD events but also to mitigate such vulnerabilities.

40. The comments opposing the NOPR directive offer two rationales for approving Reliability Standard TPL-007-2 without directing modifications at this time: (1) Reliability Standard TPL-007-2 provides sufficient protection against supplemental GMD

⁴⁷ Reclamation Comments at 1; Resilient Societies Comments at 3.

event vulnerabilities; and (2) requiring mitigation of supplemental GMD events is premature at this time.

41. With respect to the first rationale, NERC observes that the provision requiring applicable entities to consider supplemental GMD event mitigation is not “merely advisory.” However, there is no dispute that an applicable entity must “consider” mitigation under Reliability Standard TPL-007-2. What is significant is that after having done so, an applicable entity has no obligation under Reliability Standard TPL-007-2 to implement mitigation even if the applicable entity “considered” mitigation necessary to address an assessed supplemental GMD event vulnerability.

42. NERC also maintains that Reliability Standard EOP-010-1 requires transmission operators to “develop, maintain, and implement a GMD Operating Procedure or Operating Process to mitigate the effects of GMD events on the reliable operation of its respective system.” And in Order No. 779, the Commission determined that “while the development of the required mitigation plan [for benchmark GMD event vulnerabilities] cannot be limited to considering operational procedures or enhanced training alone, operational procedures and enhanced training may be sufficient if that is verified by the vulnerability assessments.”⁴⁸ Again, NERC’s point does not resolve the Commission’s concern because Reliability Standard EOP-010-1 does not ensure mitigation of all supplemental GMD event vulnerabilities assessed under Reliability Standard TPL-007-2. That is because: (1) Reliability Standard EOP-010-1 applies, in relevant part, only to

⁴⁸ Order No. 779, 143 FERC ¶ 61,147 at P 83.

transmission operators (viz., it does not apply to other applicable entity types, such as planning coordinators, transmission planners and generator owners, subject to Reliability Standard TPL-007-2); and (2) Reliability Standard EOP-010-1 does not require mitigation if the supplemental GMD event vulnerability cannot be addressed through operational procedures or enhanced training alone. Thus, Reliability Standard EOP-010-1 does not ensure satisfactory mitigation or provide an adequate substitute for mitigation as contemplated in Order No. 830.

43. In addition, NERC asserts that the required mitigation of benchmark GMD event vulnerabilities could also address supplemental GMD event vulnerabilities. Of course that may occur in some circumstances, but that is not a substitute for requiring mitigation to the extent that benchmark GMD event mitigation does not completely address a supplemental GMD event vulnerability. Under Reliability Standard TPL-007-2 there is currently no requirement to mitigate the remaining vulnerability to the Bulk-Power System.

44. Regarding the second rationale in the NOPR comments, NERC and other commenters reiterate the assertion in NERC's petition that it would be premature, from a technical standpoint, to require corrective action plans to address supplemental GMD event vulnerabilities. As reflected in the comment summary, these commenters instead request that NERC complete the GMD research work plan and then produce a report that assesses the possible need for modifications to Reliability Standard TPL-007-2.

45. The NOPR discussed how a standard drafting team could use new information gathered through the GMD research work plan to develop a modified Reliability

Standard. The Commission noted that Task 1 of the GMD research work plan (Further Analyze Spatial Averaging Used in the Benchmark GMD Event), which encompasses localized GMD event research, would be delivered in 2019 according to the most recent version of the GMD research work plan (i.e., the revised GMD research work plan). The NOPR stated that “[s]uch GMD research on localized events should inform the standard development process and aid applicable entities when implementing a modified Reliability Standard.”⁴⁹ While we appreciate that the informational filing for Task 1 may not be submitted to the Commission prior to the deadline for submitting a modified Reliability Standard, the underlying research in Task 1 is scheduled to be completed before then. As such, the standard drafting team and personnel working on the GMD research work plan could operate in parallel and share information to ensure that research relevant to the Commission’s directive is incorporated into the modified Reliability Standard. Thus we are not persuaded by the comments seeking a delay of our directive.

46. We are not persuaded by the other points raised by commenters to support their assertion that requiring corrective action plans is premature. First, NERC assumes that under such a requirement “many” applicable entities will adopt a “conservative approach” and use the supplemental GMD event definition in all GMD vulnerability assessments, thus effectively supplanting the benchmark GMD event definition. NERC bases this assumption on the standard drafting team’s “extensive experience in system

⁴⁹ NOPR, 163 FERC ¶ 61,126 at P 39.

planning and the relative immaturity of tools and methods for modeling localized enhancements.”⁵⁰ NERC acknowledges the discussion in the NOPR on how uncertainties regarding the supplemental GMD event definition—in particular the geographic size of localized events—are ameliorated by the flexibility afforded by Reliability Standard TPL-007-2. Specifically, Reliability Standard TPL-007-2 permits applicable entities to apply the supplemental GMD event definition to an entire planning area or any subset of a planning area. However, NERC asserts that even with this flexibility, at least some applicable entities would default to using the supplemental GMD event definition in an overly-broad manner. Notwithstanding NERC’s assertion, nothing in Reliability Standard TPL-007-2 requires applicable entities to apply the supplemental GMD event definition to an entire planning area or otherwise supplant the benchmark GMD event definition.

47. With respect to the statement in the NOPR that modeling tools are currently available to support corrective action plans, NERC admits that “some commercially-available modeling tools now advertise capabilities that could be used to model localized GMD enhancements.”⁵¹ However, NERC contends that to its “knowledge these capabilities have not been used extensively by planners, nor have the different software tools been benchmarked for consistency in result.”⁵² Given that GMDs have only recently been addressed in the Reliability Standards and there is currently no requirement

⁵⁰ NERC Comments at 14.

⁵¹ *Id.* at 15.

⁵² *Id.* at 15-16.

to model and assess, let alone mitigate, localized GMD events, it is not unexpected that these modeling tools have not been used extensively for that purpose. Moreover, NERC does not assert that existing tools are incapable of performing the desired modeling function.⁵³ Thus, NERC's objections on this point are not persuasive.

48. NERC does not offer support for its comment in response to the NOPR's observation that sensitivity analysis can serve, among other methods, as a method to refine the geographic scope of localized GMD impacts on planning areas. NERC responds that it "does not believe that concerns regarding the uncertainty of the geographic size of the supplemental GMD event could be addressed adequately by sensitivity analysis or through other methods in planning studies."⁵⁴ NERC claims there are already inherent sources of modeling uncertainty and that introducing another variable, such as the size of the localized enhancement, "may not improve the accuracy of the GMD Vulnerability Analysis."⁵⁵ And yet NERC's concern implies that the benchmark GMD event contains a geographic domain that does not itself inject uncertainties. However, as the Commission stated in Order No. 830, the geographic area for spatial averaging in the benchmark GMD event definition is itself a "subjective"

⁵³ *See also* Trade Associations Comments at 8 ("Although current tools are available to model localized events, we understand that such modeling will require significant time as the processes involved are still largely manual, making it difficult to develop accurate, system-wide models that appropriately consider the localized impacts of the supplemental GMD event.").

⁵⁴ NERC Comments at 15.

⁵⁵ *Id.*

figure.⁵⁶ Indeed, in Order No. 830, as part of the GMD research work plan directive, to address the uncertainties surrounding the geographic scale of spatial averaging, the Commission directed that NERC should “further analyze the area over which spatial averaging should be calculated for stability studies, including performing sensitivity analyses on squares less than 500 km per side (e.g., 100 km, 200 km),” which NERC is addressing in Task 1.⁵⁷ As such, we see no basis, technical or otherwise, for not requiring corrective action plans for assessed supplemental GMD event vulnerabilities while requiring corrective action plans for assessed benchmark GMD event vulnerabilities consistent with the Commission’s directions in Order Nos. 779 and 830. Accordingly, the Commission is not persuaded by the arguments of NERC and other commenters for the reasons discussed above, and directs that NERC develop modifications to Reliability Standard TPL-007-2 to require corrective action plans for assessed supplemental GMD event vulnerabilities.

B. Corrective Action Plan Deadline Extensions

NOPR

⁵⁶ Order No. 830, 156 FERC ¶ 61,215 at P 45 (quoting Pulkkinen, A., Bernabeu, E., Eichner, J., Viljanen, A., Ngwira, C., “Regional-Scale High-Latitude Extreme Geoelectric Fields Pertaining to Geomagnetically Induced Currents,” *Earth, Planets and Space* at 2 (June 19, 2015)).

⁵⁷ *Id.* P 26; *see also* revised GMD Research Work Plan (Task 1) at 6 (“further analyze the area over which spatial averaging should be used in stability studies and transformer thermal assessments by performing GIC analysis on squares less than 500 km per side (e.g., 100 km, 200 km) and using the results to perform power flow and transformer thermal assessments”).

49. The NOPR stated that Requirement R7.4 of Reliability Standard TPL-007-2 differs from Order No. 830 by allowing applicable entities to “revise” or “update” corrective action plans to extend deadlines. This provision contrasts with the guidance in Order No. 830 that “NERC should consider extensions of time on a case-by-case basis.” While agreeing that there should be a mechanism for allowing extensions of corrective action plan implementation deadlines, the NOPR expressed concern with unnecessary delays in implementing protection against GMD threats.

50. The NOPR identified two options for addressing Requirement R7.4. Under the first option, the Commission would, pursuant to section 215(d)(5) of the FPA, direct NERC to modify Reliability Standard TPL-007-2 to comport with Order No. 830, by requiring that NERC and the Regional Entities, as appropriate, consider requests for extension of time on a case-by-case basis. Under this option, responsible entities seeking an extension would submit the information required by Requirement R7.4 to NERC and the Regional Entities for their consideration of the request. The Commission would also direct NERC to prepare and submit a report addressing the disposition of any such requests, as well as information regarding how often and why applicable entities are exceeding corrective action plan deadlines following implementation of Reliability Standard TPL-007-2. Under such a directive, NERC would submit the report within 12 months from the date on which applicable entities must comply with the last requirement of Reliability Standard TPL-007-2. Following receipt of the report, the Commission would determine whether further action is necessary. Under the second option, the Commission would approve proposed Requirement R7.4 but also direct NERC to prepare

and submit the report described in the first option (without the statistics on disposition). Following receipt of the report, the Commission would determine whether further action is necessary.

Comments

51. NERC supports the second option in the NOPR. NERC contends that Reliability Standard TPL-007-2 “provides clarity and certainty regarding when an entity may extend a Corrective Action Plan mitigation deadline and what steps must be followed to maintain accountability and thus compliance with the standard.”⁵⁸ NERC also maintains that the proposal “avoids the administrative burden, uncertainty, and further delay that could be associated with implementing a new ERO adjudication process, such as one that would be dedicated to evaluating GMD Corrective Action Plan deadline extensions on a case-by-case basis.”⁵⁹ To address concerns regarding the possible abuse of deadline extensions, NERC states that as “part of the compliance monitoring and enforcement activities for the proposed standard, NERC and Regional Entity staff would exercise their authority to review the reasonableness of any Corrective Action Plan delay, including reviewing the ‘situations beyond the control of the responsible entity’ that are cited as causing the delay.”⁶⁰ As noted in the Supplemental Material section of Reliability Standard TPL-007-2, NERC explains that examples of such situations include “lengthy

⁵⁸ NERC Comments at 20.

⁵⁹ *Id.*

⁶⁰ *Id.* at 20-21.

legal or regulatory processes, stakeholder processes required by tariff, or long equipment lead times.”⁶¹ NERC, moreover, “agrees that a report describing the results of NERC’s monitoring of this provision could provide useful information ... [and] therefore commits to prepare and submit to the Commission a report that describes how often and the reasons why entities in the United States are exceeding Corrective Action Plan deadlines.”⁶²

52. Trade Associations, BPA, ISO NE, Idaho Power, and TVA support the second option and echo the rationale for adopting the second option in NERC’s comments. Trade Associations explain that while they previously supported a case-by-case exception process, they now believe NERC’s proposal to be more efficient and effective. Trade Associations contend that a case-by-case approach would “only increase administrative tasks for NERC and applicable entities ... [and] would further delay any actions to mitigate rather than expedite the approval process.”⁶³ Trade Associations also maintain that Reliability Standard TPL-007-2 “will not delay mitigation because this requirement is only applicable if circumstances are beyond the entity’s control.”⁶⁴

53. Reclamation does not appear to support modifying Requirement R7 to institute a case-by-case time extension process. However, Reclamation comments that the sub-requirement in Requirement R7.4.1 requiring documentation of reasons for delaying

⁶¹ *Id.* at 20.

⁶² *Id.* at 22.

⁶³ Trade Associations Comments at 13.

⁶⁴ *Id.*

corrective action plans should be eliminated because it “is merely a compliance exercise and does not improve Bulk Electric System reliability.” Reclamation makes the same contention regarding the sub-requirement in Requirement R7.4.2 that a revised corrective action plan describe the original corrective action plan.

Commission Determination

54. Reliability Standard TPL-007-2, Requirement R7.4 differs from Order No. 830 by allowing applicable entities, under certain conditions, to extend corrective action plan implementation deadlines without prior approval. This conflicts with the Commission’s guidance in Order No. 830 that, using its compliance discretion, “NERC should consider extensions of time on a case-by-case basis.”⁶⁵ Based on our consideration of the record, we believe that the case-by-case review process contemplated by Order No. 830 is the appropriate means for considering extension requests. Accordingly, pursuant to section 215(d)(5) of the FPA, we direct that NERC develop modifications to Reliability Standard TPL-007-2 to replace the time-extension provision in Requirement R7.4 with a process through which extensions of time are considered on a case-by-case basis.

55. At the outset, we note that the extension process in Requirement R7.4 applies only to the implementation of corrective action plans and not to the development of corrective action plans.⁶⁶ NERC and other commenters supportive of the second option in the

⁶⁵ Order No. 830, 156 FERC ¶ 61,215 at P 102.

⁶⁶ Reliability Standard TPL-007-2, Requirement R7.4 (“[t]he [corrective action plan] shall ... [b]e revised if situations beyond the control of the responsible entity ... prevent implementation of the [corrective action plan] within the timetable for implementation”).

NOPR urge approval of Requirement R7.4 without modification largely because of the perceived uncertainty and burden associated with treating extension requests on a case-by-case basis. While it is true that granting extensions on a case-by-case basis involves more uncertainty and potential burdens versus the automatic extension of time afforded by Requirement R7.4, we must weigh this against the potential for abuse of Requirement R7.4 to unduly delay mitigation, as well as the delayed visibility that NERC would have into the deployment of needed GMD protections. Presented with these competing concerns, we conclude that the imperative to address known GMD vulnerabilities in a timely manner, and without unwarranted delays, is more compelling. We recognize that applicable entities that have a legitimate need for extensions require timely responses from NERC and Regional Entities, as appropriate. Accordingly, we expect that the extension process developed by NERC in response to our directive will be timely and efficient such that applicable entities will receive prompt responses after submitting to NERC or a Regional Entity, as appropriate, the extension request and associated information described in Requirement R7.4.⁶⁷

56. In reaching our determination on this issue, we considered NERC's NOPR comments, which attempted to address the concerns with Requirement R7.4 expressed in the NOPR, stating that NERC and Regional Entity compliance and enforcement staff will review the reasonableness of any delay in implementing corrective action plans, including reviewing the asserted "situations beyond the control of the responsible entity"

⁶⁷ NOPR, 163 FERC ¶ 61,126 at P 50.

cited by the applicable entity, and by citing specific examples of the types of delays that might justify the invocation of Requirement R7.4. NERC's comments also characterized Requirement R7.4 as being "not so flexible ... as to allow entities to extend Corrective Action Plan deadlines indefinitely or for any reason whatsoever."⁶⁸ We generally agree with the standard of review that NERC indicates it will use to determine whether an extension of time to implement a corrective action plan is appropriate. However, the assessment of whether an extension of time is warranted is more appropriately made before an applicable entity is permitted to delay mitigation of a known GMD vulnerability. While NERC indicates that under proposed Requirement R7.4 there are compliance consequences for improperly delaying mitigation, mitigation of a known GMD vulnerability will nonetheless have been delayed, and we conclude it is important that any proposed delay be reviewed ahead of time. Therefore, we direct NERC to modify Reliability Standard TPL-007-2, Requirement R7.4 to develop a timely and efficient process, consistent with the Commission's guidance in Order No. 830, to consider time extension requests on a case-by-case basis.

57. We disagree with Reclamation's comment regarding Requirement R7.4.1, which requires a description of the circumstances necessitating mitigation delays, because it is at odds with NERC's NOPR comments, discussed above, in which NERC states that NERC and Regional Entities will review the reasons for delaying mitigation. Contrary to Reclamation's assertion that this requirement is "merely a documentation exercise and

⁶⁸ NERC Comments at 20.

does not improve [bulk electric system] reliability,” unreasonable delays of mitigation could harm bulk electric system reliability by leaving it vulnerable to GMDs. Moreover, Requirement R7.4.2, also opposed by Reclamation, requiring that revised corrective action plans describe the original and previous revisions, provides compliance enforcement authorities with a revision history of the corrective action plan in a single document, thus facilitating compliance review.

C. Other Issues Raised in NOPR Comments

58. Resilient Societies’ comments raise three issues not addressed in the NOPR. First, Resilient Societies maintains that transformers that experience an estimated GIC above 15 A/phase should be subject to mandatory corrective action plans and the Commission should “encourage owner-operators and their research partners to develop ‘Corrective Action Plans’ for both [extra high voltage] transformers and for associated generation stations, even if these long replacement-time systems experience overstress at levels significantly below 75 amps per phase.” Second, Resilient Societies states that the Commission should encourage best practices by industry beyond the mandatory requirements of the Reliability Standards, including allowing cost recovery for such practices. Third, Resilient Societies states that the Commission should address combined GMD and electromagnetic pulse (EMP) protection.

59. In Order No. 830, the Commission approved the 75 A/phase threshold in Reliability Standard TPL-007-1 based on the record and despite objections from certain commenters. The Commission, however, directed further study of this issue as part of the GMD research work plan. Resilient Societies’ comments provide no new basis for

revisiting this issue at this time. Moreover, as reflected in the NOPR proposal, NERC has adequately supported the 85 A/phase threshold proposed in Reliability Standard TPL-007-2 for the supplemental GMD event analysis. However, new information resulting from the GMD research work plan will also be relevant to this higher threshold. We will consider such research at the appropriate time.

60. In Order No. 830, the Commission stated that “cost recovery for prudent costs associated with or incurred to comply with Reliability Standard TPL-007-1 and future revisions to the Reliability Standard will be available to registered entities.”⁶⁹ It is therefore beyond the scope of this proceeding to determine, as a general matter, whether voluntary measures beyond those required to comply with the governing Reliability Standards are eligible for cost recovery. That said, jurisdictional entities may of course pursue such voluntary measures, and the Commission would consider appropriate cost recovery for those investments through a formula rate or other rate proceeding.

61. The Commission in previous orders has indicated that the Commission’s GMD proceedings are not directed to EMPs and thus Resilient Societies’ comments on EMP are out-of-scope.⁷⁰

⁶⁹ Order No. 830, 156 FERC ¶ 61,215 at P 24.

⁷⁰ *See, e.g.*, Order No. 830, 156 FERC ¶ 61,215 at P 119.

D. Revised GMD Research Work Plan

62. On April 19, 2018, NERC submitted a revised GMD research work plan in response to a Commission order issued on October 19, 2017.⁷¹ In the October 19 Order, the Commission accepted the initial GMD research work plan filed by NERC on May 30, 2017. The Commission also directed NERC to file a final GMD research work plan within six months and ensure that the final GMD research work plan included a reevaluation of reliance on single station readings when adjusting for latitude as part of the benchmark GMD event definition. At NERC's request, the October 19 Order also provided guidance on how NERC should prioritize the tasks in the GMD research work plan.

63. Bardin and Resilient Societies submitted comments in response to the revised GMD research work plan, which largely focused on a request for combined research on GMDs and EMPs. As discussed above, however, EMPs are outside the scope of the Commission's directive regarding GMD research. Resilient Societies also submitted comments criticizing aspects of five tasks in the revised GMD research work plan. With respect to Tasks 1, 2, 8 and 9, Resilient Societies' criticism is based on the contention that the "real-world data" will not be used to verify models. For example, Resilient Societies contends that NERC will not use "real-world" GIC data to validate spatial averaging (Task 1) or latitude scaling (Task 2). These assertions, however, are refuted by

⁷¹ *Reliability Standard for Transmission System Planned Performance for Geomagnetic Disturbance Events*, 161 FERC ¶ 61,048 (2017) (October 19 Order).

the revised GMD research work plan. The revised GMD research work plan indicates that the research on spatial averaging includes an analysis of “a large number (10-20) of localized extreme events and collection of both ground-based and space-based data around the times of these events.”⁷² For latitude scaling, the revised GMD research work plan states that NERC will evaluate the scaling factor “using existing models and developing new models to extrapolate, from historical data, the potential scaling of a 1-in-100 year GMD event on lower geomagnetic latitudes.”⁷³ In addition, NERC indicates that the data gathered through the Section 1600 data request “will help validate various models used in calculating GIC’s and assessing their impacts in data systems.”⁷⁴

64. Resilient Societies other comments are directed to an alleged lack of specificity, granularity or “scientific assurance” in the testing described in Tasks 5, 8 and 9 of the revised GMD research work plan. These criticisms are misplaced as they demand an unreasonable degree of detail in the revised GMD research work plan. For example, regarding Task 5, NERC states that it will “validate[e] existing transformer tools with all data that is presently available and with upcoming field/laboratory test results.”⁷⁵ Resilient Societies, however, contends unpersuasively that “NERC neglects to specify

⁷² Revised GMD Research Work Plan, Attachment 1 (Order No. 830 GMD Research Work Plan (April 2018)) at 2.

⁷³ *Id.* at 8.

⁷⁴ *Id.* at 19.

⁷⁵ *Id.* at 17.

‘all data that is presently available’ ... and the number of transformers to be employed in ‘upcoming field laboratory test results’ and also neglects to disclose details of the test protocols to be used.”⁷⁶ Regarding harmonics (Tasks 8 and 9), Task 9 specifically includes “tank vibration measurements,” not just simulations.⁷⁷ Moreover, Task 8 (Improving Harmonic Analysis Capabilities) is intended to develop more basic information than some of the other tasks in the revised GMD research work plan where industry has more knowledge. As with all of the revised GMD research work plan tasks (with the exception of Task 6, which deals with the Section 1600 data request), NERC will submit a report to the Commission on its findings.

65. As the revised GMD research work plan complies with Order No. 830 and the Commission’s October 19 Order, we accept the revised GMD research work plan.

III. Information Collection Statement

66. The collection of information contained in this final rule is subject to review by the Office of Management and Budget (OMB) under section 3507(d) of the Paperwork Reduction Act of 1995.⁷⁸ OMB’s regulations require review and approval of certain information collection requirements imposed by agency rules.⁷⁹ Upon approval of a collection of information, OMB will assign an OMB control number and an expiration

⁷⁶ Resilient Societies Comments on Revised GMD Research Work Plan at 11.

⁷⁷ *Id.* at 25.

⁷⁸ 44 U.S.C. 3507(d).

⁷⁹ 5 CFR 1320 (2018).

date. Respondents subject to the information collection requirements of a rule will not be penalized for failing to respond to the collection of information unless the collection of information displays a valid OMB control number.

67. In the NOPR, the Commission solicited comments on the need for this information, whether the information will have practical utility, the accuracy of the burden estimates, ways to enhance the quality, utility, and clarity of the information to be collected or retained, and any suggested methods for minimizing respondents' burden, including the use of automated information techniques. Specifically, the Commission asked that any revised burden or cost estimates submitted by commenters be supported by sufficient detail to understand how the estimates were generated. The Commission did not receive any comments regarding the Commission's burden estimates.

68. The Commission approves Reliability Standard TPL-007-2, which replaces currently-effective Reliability Standard TPL-007-1. When compared to Reliability Standard TPL-007-1, Reliability Standard TPL-007-2 maintains the current information collection requirements, modifies existing Requirements R1 through R7 and adds new requirements in Requirements R8 through R12.

69. Reliability Standard TPL-007-2 includes new corrective action plan development and implementation deadlines in Requirement R7, new supplemental GMD vulnerability and transformer thermal impact assessments in Requirements R8 through R10, and requirements for applicable entities to gather magnetometer and GIC monitored data in Requirements R11 and R12. Deadlines in Requirement R7 for the development and implementation of corrective action plans would only change the timeline of such

documentation and are not expected to revise the burden to applicable entities. The burden estimates for new Requirements R8 through R10 are expected to be similar to the burden estimates for Requirements R4 through R6 in currently-effective Reliability Standard TPL-007-1 due to the closely-mirrored requirements.⁸⁰ The Commission expects that only 25 percent or fewer of transmission owners and generator owners would have to complete a supplemental transformer thermal impact assessment per Requirement R10. Requirements R11 and R12 require applicable entities to have a process to collect GIC and magnetometer data from meters in planning coordinator planning areas.

Public Reporting Burden: The burden and cost estimates below are based on the changes to the reporting and recordkeeping burden imposed by Reliability Standard TPL-007-2. Our estimates for the number of respondents are based on the NERC Compliance Registry as of March 3, 2018, which indicates there are 183 entities registered as transmission planner (TP), 65 planning coordinators (PC), 330 transmission owners (TO), 944 generator owners (GO) within the United States. However, due to significant overlap, the total number of unique affected entities (i.e., entities registered as a transmission planner, planning coordinator, transmission owner or generator owner, or some combination of these functional entities) is 1,130 entities. This includes 188 entities that are registered as a transmission planner or planning coordinator (applicability for Requirements R7 to R9 and R11 to R12), and 1,119 entities registered as a transmission or generation owner (applicability for Requirement R10). Given the

⁸⁰ NERC Petition at 14-17.

assumption above, there is an expectation that at most only 25 percent of the 1,119 entities (or 280 entities) will have to complete compliance activities for Requirement R10. The estimated burden and cost are as follow.⁸¹

FERC-725N, Changes Due to Final Rule in Docket No. RM18-8^{82, 83}						
Requirement (R)	Number and Type of Respondents (1)	Annual Number of Responses Per Respondent (2)	Total No. of Responses (1)X(2)=(3)	Average Burden Hrs. & Cost per Response (4)	Total Annual Burden Hrs. & Total Annual Cost (rounded)	Cost per Respondent (\$) (5)÷(1)

⁸¹ Hourly costs are based on the Bureau of Labor Statistics (BLS) figures for May 2017 (Sector 22, Utilities) for wages (https://www.bls.gov/oes/current/naics2_22.htm) and benefits for December 2017 (<https://www.bls.gov/news.release/ecec.nr0.htm>). We estimate that an Electrical Engineer (NAICS code 17-2071) would perform the functions associated with reporting requirements, at an average hourly cost (for wages and benefits) of \$66.90. The functions associated with recordkeeping requirements, we estimate, would be performed by a File Clerk (NAICS code 43-4071) at an average hourly cost of \$32.04 for wages and benefits.

The estimated burden and cost are in addition to the burden and cost that are associated with the existing requirements in Reliability Standard TPL-007-1 (and in the current OMB-approved inventory), which would continue under Reliability Standard TPL-007-2.

The requirements for NERC to provide reports to the Commission and to develop and submit modifications to Reliability Standard TPL-007-2 are already covered under FERC-725 (OMB Control No. 1902-0225).

⁸² Rep.=reporting requirements; RK =recordkeeping requirements (Evidence Retention).

⁸³ For each Reliability Standard, the Measure shows the acceptable evidence (Reporting Requirement) for the associated Requirement (R numbers), and the Compliance section details the related Recordkeeping Requirement.

					(3)X(4)=(5)	
R1 through R6 ⁸⁴	No change	No change	No change	No change	No change	No change
R7	188 (PC and TP)	1/5 (once for every five year study)	37.6	Rep. 5 hrs., \$334.50; RK 5 hrs., \$160.20	Rep. 188 hrs., \$12,577; RK 188 hrs., \$6,023	Rep. 1 hr., \$66.90; RK 1 hr., \$32.04
R8	188 (PC and TP)	1/5 (once for every five year study)	37.6	Rep., 27 hrs., \$1,806.30; RK, 21 hrs., \$672.84	Rep. 1,015 hrs., \$67,917; RK 790 hrs., \$25,299	Rep., 5.4 hrs., \$361.26; RK 4.2 hrs., \$134.57
R9	188 (PC and TP)	1/5 (once for every five year study)	37.6	Rep. 9 hrs., \$602.10; RK 7 hrs., \$224.28	Rep. 338 hrs., \$22,639; RK 263 hrs., \$8,432	Rep. 1.8 hrs., \$120.42; RK 1.4 hrs., \$44.85
R10	280 (25% of 1,119) (GO and TO)	1/5 (once for every five year study)	56	Rep. 22 hrs., \$1,471.80; RK 18 hrs., \$576.72	Rep. 1,232 hrs., \$82,421; RK 1,008 hrs., \$32,296	Rep. 4.4 hrs., \$294.36; RK 3.6 hrs., \$115.34
R11	188 (PC and TP)	1 (on-going reporting)	188	Rep. 10 hrs., \$669; RK. 10 hrs., \$320.40	Rep. 1,880 hrs., \$125,772; RK 1,880 hrs., \$60,235	Rep. 10 hrs., \$669; RK 10 hrs., \$320.40

⁸⁴ While Reliability Standard TPL-007-2 extends the requirements in existing Reliability Standard TPL-007-1, Requirements R1 through R3 to the newly required supplemental GMD event analyses, the obligation to conduct the supplemental GMD event analyses is found in Reliability Standard TPL-007-2, Requirements R8 through R10.

R12	188 (PC and TP)	1 (on- going reporting)	188	Rep. 10 hrs., \$669; RK. 10 hrs., 320.40	Rep. 1,880 hrs. \$125,772; RK 1,880 hrs., \$60,235	Rep. 10 hrs., \$669; RK 10 hrs., \$320.40
Total Additional Hrs. and Cost (rounded), due to Final Rule in RM18-8					Rep., 6,533 hrs., \$437,057; RK 6,009 hrs., \$192,528	

Title: FERC-725N, Mandatory Reliability Standards: TPL Reliability Standards

Action: Revisions to an existing collection of information

OMB Control No: 1902-0264

Respondents: Business or other for profit, and not for profit institutions.

Frequency of Responses:⁸⁵ Every five years (for Requirement R7-R10), annually (for Requirement R11 and R12), and ongoing.

Necessity of the Information: Reliability Standard TPL-007-2 implements the Congressional mandate of the Energy Policy Act of 2005 to develop mandatory and enforceable Reliability Standards to better ensure the reliability of the nation’s Bulk-Power System. Specifically, these requirements address the threat posed by GMD events

⁸⁵ The frequency of Requirements R1 through R6 in Reliability Standard TPL-007-2 is unchanged from the existing requirements in Reliability Standard TPL-007-1.

to the Bulk-Power System and conform to the Commission's directives to modify Reliability Standard TPL-007-1 as directed in Order No. 830.

Internal review: The Commission has reviewed Reliability Standard TPL-007-2, and made a determination that its action is necessary to implement section 215 of the FPA.

The Commission has assured itself, by means of its internal review, that there is specific, objective support for the burden estimates associated with the information requirements.

70. Interested persons may obtain information on the reporting requirements by contacting the Federal Energy Regulatory Commission, Office of the Executive Director, 888 First Street, NE, Washington, DC 20426 [Attention: Ellen Brown, e-mail: DataClearance@ferc.gov, phone: (202) 502-8663, fax: (202) 273-0873].

71. Comments concerning the collection of information and the associated burden estimate should be sent to the Commission in this docket and may also be sent to the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th Street, NW, Washington, DC 20503 [Attention: Desk Officer for the Federal Energy Regulatory Commission]. Due to security concerns, comments should be sent electronically to the following e-mail address: oir_submission@omb.eop.gov.

Comments submitted to OMB should refer to FERC-725N and OMB Control No. 1902-0264.

IV. Environmental Analysis

72. The Commission is required to prepare an Environmental Assessment or an Environmental Impact Statement for any action that may have a significant adverse effect

on the human environment.⁸⁶ The Commission has categorically excluded certain actions from this requirement as not having a significant effect on the human environment.

Included in the exclusion are rules that are clarifying, corrective, or procedural or that do not substantially change the effect of the regulations being amended.⁸⁷ The actions here fall within this categorical exclusion in the Commission's regulations.

V. Regulatory Flexibility Act

73. The Regulatory Flexibility Act of 1980 (RFA)⁸⁸ generally requires a description and analysis of proposed rules that will have significant economic impact on a substantial number of small entities. The definition of small business is provided by the Small Business Administration (SBA) at 13 CFR 121.201. The threshold for a small utility (using SBA's sub-sector 221) is based on the number of employees for a concern and its affiliates. As discussed above, Reliability Standard TPL-007-2 applies to a total of 1,130 unique planning coordinators, transmission planners, transmission owners, and generation owners.⁸⁹ A small utility (and its affiliates) is defined as having no more than

⁸⁶ Regulations Implementing the National Environmental Policy Act of 1969, Order No. 486, FERC Stats. & Regs. ¶ 30,783 (1987) (cross-referenced at 41 FERC ¶ 61,284).

⁸⁷ 18 CFR 380.4(a)(2)(ii) (2018).

⁸⁸ 5 U.S.C. 601-12.

⁸⁹ In the NERC Registry, there are approximately 65 PCs, 188 TPs, 944 GOs, and 330 TOs (in the United States), which will be affected by this final rule. Because some entities serve in more than one role, these figures involve some double counting.

the following number of employees:

- for planning coordinators, transmission planners, and transmission owners (NAICS code 221121, Electric Bulk Power Transmission and Control), a maximum of 500 employees
- for generator owners, a maximum of 750 employees.⁹⁰

74. As estimated in the NOPR, the total cost to all entities (large and small) is \$629,585 annually (or an average of \$1,345.27 for each of the estimated 468 entities affected annually). For the estimated 280 generator owners and transmission owners affected annually, the average cost would be \$409.70 per year. For the estimated 188 planning coordinators and transmission planners, the estimated average annual cost would be \$2,738.84. The estimated annual cost to each affected entity varies from \$409.70 to \$2,738.84 and is not considered significant. The Commission did not receive any comments regarding these burden and cost estimates.

75. Accordingly, the Commission certifies that this final rule will not have a significant economic impact on a substantial number of small entities.

VI. Document Availability

76. In addition to publishing the full text of this document in the Federal Register, the Commission provides all interested persons an opportunity to view and/or print the

⁹⁰ The maximum number of employees for a generator owner (and its affiliates) to be “small” varies from 250 to 750 employees, depending on the type of generation (e.g., hydroelectric, nuclear, fossil fuel, wind). For this analysis, we use the most conservative threshold of 750 employees.

contents of this document via the Internet through FERC's Home Page (<http://www.ferc.gov>) and in FERC's Public Reference Room during normal business hours (8:30 a.m. to 5:00 p.m. Eastern time) at 888 First Street, NE, Room 2A, Washington DC 20426.

77. From FERC's Home Page on the Internet, this information is available on eLibrary. The full text of this document is available on eLibrary in PDF and Microsoft Word format for viewing, printing, and/or downloading. To access this document in eLibrary, type the docket number excluding the last three digits of this document in the docket number field.

78. User assistance is available for eLibrary and the FERC's website during normal business hours from FERC Online Support at (202) 502-6652 (toll free at 1-866-208-3676) or email at ferconlinesupport@ferc.gov, or the Public Reference Room at (202) 502-8371, TTY (202)502-8659. E-mail the Public Reference Room at public.referenceroom@ferc.gov.

VII. Effective Date and Congressional Notification

79. These regulations are effective [**INSERT DATE 60 days after publication in the FEDERAL REGISTER**]. The Commission has determined, with the concurrence of the Administrator of the Office of Information and Regulatory Affairs of OMB, that this rule is not a "major rule" as defined in section 351 of the Small Business Regulatory

Enforcement Fairness Act of 1996. The rule will be provided to the Senate, House, Government Accountability Office, and the SBA.

By the Commission. Commissioner McIntyre is not voting on this order.

(S E A L)

Nathaniel J. Davis, Sr.,
Deputy Secretary.

APPENDIX

List of Commenters

Abbreviation

Commenter

Bardin	David Bardin
BPA	Bonneville Power Administration
Idaho Power	Idaho Power Company
ISO NE	ISO New England Inc.
NERC	North American Electric Reliability Corporation
Reclamation	Bureau of Reclamation
Resilient Societies	Foundation for Resilient Societies
Trade Associations	American Public Power Association, Edison Electric Institute, Electricity Consumers Resource Council, Large Public Power Council, National Rural Electric Cooperative Association
TVA	Tennessee Valley Authority