



SPP TPL-007-1 Standard Guidance Document

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SPP Planning

Revision History

Date or Version Number	Author	Change Description	Comments
12/15/2016	TPL Task Force	Proposed draft	Proposed draft
03/02/2017	TPL Task Force	Revised draft	Draft incorporates changes reflecting comments received.

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Executive Summary

This document consists of two parts. Section 1¹ annotates the requirements of the North American Electric Reliability Corporation (NERC) Transmission System Planning TPL-007-1 standard and identifies respective responsibilities between SPP, as the Planning Coordinator, and its members, as Transmission Planners, Transmission Owners, and Generator Owners. Section 2² is intended to provide guidance for these entities towards meeting their responsibilities in accordance with TPL-007-1.

¹ Section 1 will require review by the Transmission Planning Task Force (TPLTF), Model Development Working Group (MDWG), Reliability Compliance Working Group (RCWG) and Transmission Working Group (TWG) and approval by the TPLTF and TWG.

² Section 2 is intended for continuous improvement and is subject to amendment as further experience is gained through the performance of the initial and subsequent GMD Vulnerability Assessments. Section 2 will be viewed as living document as SPP and its Member companies execute analysis in support of the initial GMD Vulnerability Assessment. Changes to Section 2 will require review by TPLTF and approval by the TPLTF.

Terminology

The purpose of this section is to clarify terms used in this guidance document.

Geomagnetic Disturbance (GMD): Perturbations in space weather that lead to terrestrial magnetic field interactions. When of sufficient magnitude, GMD may affect the Bulk Electric System (BES) through GIC.

Geomagnetically-Induced Current (GIC): Quasi-DC currents driven by terrestrial magnetic field changes due to GMD. GICs are quasi-DC in nature due to their low frequency (0.0001Hz to 1.0 Hz), relative to power system frequency. GICs move through transmission lines and transformer windings, along the lowest-impedance path to ground. GIC flow in transformer windings may cause half-cycle saturation of transformer cores leading to increased transformer hotspot heating, generation of harmonics, and reactive power absorption.

GIC System model: a DC-equivalent representation of the BES³ that includes all power transformers with a high side, wye-grounded winding with a terminal voltage greater than 200 kV. The GIC System model is used to calculate GIC flow on the transmission system and is based upon the traditional AC System model.

GMD Model Set: a System model-based set of steady-state models that incorporate GIC-related effects. The GMD Model Set is developed in two stages. First, the GIC System model containing GIC-related system information (such as substation grounding values, latitude/longitude, etc.) is used to determine the magnitude of GIC currents. Second, GIC currents are integrated into System models, translating GIC effects to the AC power system representations. The resultant set of System models, containing the GIC-related impacts is referred to as the GMD Model Set.

Steady-state GIC analysis: the process of determining the steady-state system impacts of GIC upon the AC power system, such as reactive power (MVAR) absorption of power transformers due to GIC. The GMD Model Set is used for steady-state GIC analysis.

System model: an AC-equivalent representation of the BES, as well as certain non-BES Elements, used to conduct steady-state load flow analysis. SPP System models are developed as part of the SPP Model Development Working Group (MDWG) model building process, in accordance with the applicable NERC Modeling, Data, and Analysis (MOD) Standards. Development of the System model is outside the scope of this guidance document.

Terminal voltage: describes line-to-line voltage.

Transmission Planning Task Force (TPLTF): the group consisting of representatives from SPP member companies and SPP staff responsible for drafting the original version of this document.

Written request, or written notification: either a certified letter or electronic letter, signed by appropriate authority at the sending entity.

³ TPL-007-1 limits the equipment necessary for modeling GIC effects. However, this document is not intended to preclude GIC-related data for non-BES equipment within the GIC System model, if submitted by an applicable entity.

Implementation Note

On 22 September 2016, the Federal Energy Regulatory Commission (FERC) issued Order 830 which approved the proposed TPL-007-1 standard. TPL-007-1 will be implemented over a 5-year period. This phased implementation allows necessary time for entities to develop the required models, proper sequencing of assessments, and necessary time for development of viable Corrective Action Plans. The requirements of TPL-007-1 will become effective according to the following implementation plan:

TPL-007-1 Requirement	Following approval, effective on the first day of the first calendar quarter after:	Enforcement Date
R1	6 months	01 July 2017
R2	18 months	01 July 2018
R3	60 months	01 January 2022
R4	60 months	01 January 2022
R5	24 months	01 January 2019
R6	48 months	01 January 2021
R7	60 months	01 January 2022

This guidance document has been composed for the purpose of addressing the individual and joint responsibilities for SPP members given implementation of the TPL-007-1 standard.

Scope of Applicability

The TPL-007-1 standard is applicable to Planning Coordinators, Transmission Planners, Transmission Owners, and Generator Owners with Facilities that include power transformers with a high side, wye-grounded winding with terminal voltage greater than 200 kV. However, data necessary to construct and maintain appropriate geomagnetic-induced current (GIC) models may extend beyond Facilities specific to the applicability of TPL-007-1 part 4.2. Therefore, this guidance document defines a broader scope of entities that may be required to supply data for the purpose of facilitating the applicable entities compliance with the requirements of TPL-007-1.

Section 1: Individual and Joint Responsibilities

This section establishes the individual and joint responsibilities for maintaining models and performing the studies needed to complete GMD Vulnerability Assessments.

R1

Requirement R1: Each Planning Coordinator, in conjunction with its Transmission Planner(s), shall identify the individual and joint responsibilities of the Planning Coordinator and Transmission Planner(s) in the Planning Coordinator's planning area for maintaining models and performing the study or studies needed to complete GMD Vulnerability Assessment(s).

Individual Responsibilities

SPP, as Planning Coordinator, shall:

- Meet the requirements of R1 by adopting the responsibilities assigned to SPP, specified in parts R2 through R7 below.

Transmission Planners, within the SPP Planning Coordinator area, shall:

- Meet the requirements of R1 by adopting the responsibilities assigned to Transmission Planners, specified in parts R2 through R7 below.

Transmission Owners, within the SPP Planning Coordinator area, shall:

- Meet the requirements of R1 by adopting the responsibilities assigned to Transmission Owners, specified in parts R2 through R7 below.

Generator Owners, within the SPP Planning Coordinator area, shall:

- Meet the requirements of R1 by adopting the responsibilities assigned to Generator Owners, specified in parts R2 through R7 below.

Joint Responsibilities

None.

R2

Requirement R2: Each responsible entity, as determined in Requirement R1, shall maintain System models and GIC System models of the responsible entity's planning area for performing the study or studies needed to complete GMD Vulnerability Assessment(s).

Individual Responsibilities

SPP, as Planning Coordinator, shall:

- Maintain the SPP GMD Model Set.
- Request updates to data and information supporting the SPP GMD Model Set from each Transmission Owner, and Generator Owner within the SPP Planning Coordinator area annually.
- Make the SPP GMD Model Set available to all Transmission Planners, Transmission Owners, and Generator Owners within the SPP Planning Coordinator area.

Transmission Owners, within the SPP Planning Coordinator area, shall:

- Provide data and information in support of the SPP GMD Model Set, to SPP as the Planning Coordinator and to the applicable Transmission Planner.
- Provide either updated data or an explanation with a technical basis within 90 days from receipt of written notification from SPP, as Planning Coordinator, or a Transmission Planner regarding technical concerns with the data submitted by the Transmission Owner under Requirement R2.

Generator Owners, within the SPP Planning Coordinator area, shall:

- Provide data and information in support of the SPP GMD Model Set, to SPP as the Planning Coordinator and to the applicable Transmission Planner.
- Provide either updated data or an explanation with a technical basis within 90 days from receipt of written notification from SPP, as Planning Coordinator, or a Transmission Planner regarding technical concerns with the data submitted by the Generator Owner under Requirement R2.

Joint Responsibilities

SPP, as Planning Coordinator, in conjunction with Transmission Planners within its Planning Coordinator area shall:

- Review the data and information submitted by Transmission Owner(s) and Generator Owner(s) within their respective planning areas, in support of the SPP GMD Model Set.
- Submit written notification to Transmission Owner(s) and Generator Owner(s) regarding technical concerns, when applicable, with data submitted in support of the SPP GMD Model Set, including the technical basis or reasons for the technical concerns.

R3

Requirement R3: Each 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.

Individual Responsibilities

SPP, as Planning Coordinator, shall:

- Have criteria for acceptable System steady-state voltage performance for its Planning Coordinator area during the benchmark GMD event.

Transmission Planners, within the SPP Planning Coordinator area, shall:

- Adopt, as minimum criteria⁴, the SPP acceptable System steady-state voltage performance criteria during the benchmark GMD event for the Facilities which it acts as Transmission Planner.

Joint Responsibilities

SPP, as Planning Coordinator, in conjunction with Transmission Planners within its Planning Coordinator area shall:

- Develop criteria for acceptable System steady-state voltage performance for its Planning Coordinator area during the benchmark GMD event.

⁴ Transmission Planners may have more restrictive criteria than SPP, as Planning Coordinator.

R4

Requirement R4: Each responsible entity, as determined in Requirement R1, shall complete a GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon once every 60 calendar months. This 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.

Individual Responsibilities

SPP, as Planning Coordinator, shall:

- Complete studies necessary for the GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon.
- Ensure that studies completed for the GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon include conditions representing System On-Peak Load for at least one year within the Near-Term Transmission Planning Horizon (R4.1.1) and System Off-Peak Load for at least one year within the Near-Term Transmission Planning Horizon (R4.1.2).
- Ensure that studies completed for the GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon determine whether the Planning Coordinator area meets the performance requirements in TPL-007-1 Table 1 under benchmark GMD event conditions (R4.2).
- Provide study results and information necessary for the GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon to the Transmission Planners within its Planning Coordinator area.
- Develop the “GMD Vulnerability Assessment Report” document, including narrative and results of the GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon.
- Provide the “GMD Vulnerability Assessment Report” to the Transmission Planners within its Planning Coordinator area, as well as SPP, as Reliability Coordinator, adjacent Planning Coordinators, adjacent Transmission Planners, and to any functional entity that submits a written request and has a reliability-related need, within 90 calendar days of completion⁵ (R4.3).

⁵ SPP, as Planning Coordinator, may receive written requests for the “GMD Vulnerability Assessment Report” after 90 calendar days from the completion of the report. For all such written requests, SPP, as Planning Coordinator, will provide the most-recently completed GMD Vulnerability Assessment Report, typically congruent with the 60 calendar months specified in TPL-007-1/R4.

- Make a documented response to recipients of the “GMD Vulnerability Assessment Report” who provide documented comments on the results, within 90 calendar days of SPP, as Planning Coordinator, receiving the comments (R4.3.1).

Transmission Planners, within the SPP Planning Coordinator area, shall:

- Review the “GMD Vulnerability Assessment Report” provided by SPP, the Planning Coordinator.
- Provide the “GMD Vulnerability Assessment Report” to the Reliability Coordinator(s), adjacent Planning Coordinator(s), or adjacent Transmission Planner(s) for the Facilities which it acts as Transmission Planner (R4.3).
- Provide the “GMD Vulnerability Assessment Report” to any functional entity⁶ that submits a written request and has a reliability-related need for information related to the Facilities for which it acts as Transmission Planner, within 90 calendar days of completion (R4.3).
- Shall make a documented response to recipients of the “GMD Vulnerability Assessment Report” who provide documented comments on the results, within 90 calendar days of the Transmission Planner receiving the comments (R4.3.1).

Joint Responsibilities

SPP, as Planning Coordinator, and Transmission Planners, within the SPP Planning Coordinator area, shall:

- Collaboratively complete a GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon once every 60 calendar months.

⁶ TPL-007-1/R4.3 specifically refers to requests from functional entities. This is interpreted to refer to entities that are NERC-registered according to roles defined by the NERC Functional Model.

R5

Requirement R5: Each responsible entity, as determined in Requirement R1, shall provide GIC flow information to be used for the transformer thermal impact assessment specified in Requirement R6 to each Transmission Owner and Generator Owner that owns an applicable Bulk Electric System (BES) power transformer in the planning area.

Individual Responsibilities

SPP, as Planning Coordinator, shall:

- Provide GIC flow information, as the maximum effective GIC value for the worst case geoelectric field orientation given the benchmark GMD event, to be used for the transformer thermal impact assessment to each Transmission Owner and Generator Owner that owns an applicable BES power transformer within the SPP Planning Coordinator area (R5.1), upon completion of the studies necessary for the GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon, within the 60-month periodicity.
- Provide GIC flow information, as the effective GIC time series [GIC(t)] given the benchmark GMD event, within 90 calendar days of a written request by a Transmission Owner or Generator Owner that owns an applicable BES power transformer within the SPP Planning Coordinator area (R5.2), upon completion of the studies necessary for the GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon, within the 60-month periodicity.
- Provide GIC flow information, given to Transmission Owners and Generator Owners within the SPP Planning Coordinator area for BES transformers, to the applicable Transmission Planner.

Joint Responsibilities⁷

None.

⁷ During development of scope documentation for the GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon, SPP, as Planning Coordinator, and Transmission Planners within the SPP Planning Coordinator area, may collaboratively determine that the NERC-provided GIC time series data is insufficient for performance of transformer thermal impact assessments, based upon actual measured data available from GIC-related sensors within the Planning Coordinator area. It is expected that SPP, as Planning Coordinator, and Transmission Planners within the SPP Planning Coordinator area, may collaboratively develop GIC time series data from measured GIC data obtained within the SPP Planning Coordinator area to replace the NERC-provided GIC time series data, when determined insufficient and justified in the GMD Vulnerability Assessment study scope.

R6

Requirement R6: Each Transmission Owner and Generator Owner shall conduct a thermal impact assessment for its solely and jointly owned applicable BES power transformers where the maximum effective GIC value provided in Requirement R5, Part 5.1, is 75 A per phase or greater.

Individual Responsibilities

Each Transmission Owner within the SPP Planning Coordinator area, shall:

- Conduct a thermal impact assessment for its solely and jointly owned applicable BES power transformers where the maximum effective GIC value is 75 A per phase or greater.
- Document the thermal impact assessments for its solely and jointly owned applicable BES power transformers in a “Transformer Thermal Impact Assessment Report”.
- Ensure that the analysis conducted in support of thermal impact assessments for its solely and jointly owned applicable BES power transformers is based upon the effective GIC value provided by SPP, as Planning Coordinator (R6.1).
- Ensure that the assumptions used in the analysis conducted in support used in the thermal impact assessment for its solely and jointly owned applicable BES power transformers are documented in the “Transformer Thermal Impact Assessment Report” (R6.2).
- Ensure that suggested actions and the analysis supporting the mitigation of GIC impacts identified in the thermal impact assessment for its solely and jointly owned applicable BES power transformers are documented in the “Transformer Thermal Impact Assessment Report” (R6.3).
- Provide its “Transformer Thermal Impact Assessment Report” for all applicable solely and jointly-owned BES power transformers within the SPP Planning Coordinator area to SPP, as Planning Coordinator, within 24 calendar months of receiving GIC flow information from SPP, as Planning Coordinator (R6.4).
- Provide its “Transformer Thermal Impact Assessment Report” for all applicable solely and jointly-owned BES power transformers within the SPP Planning Coordinator area, to the accountable Transmission Planner, within 24 calendar months of receiving GIC flow information from SPP, as Planning Coordinator (R6.4).

Each Generator Owner within the SPP Planning Coordinator area, shall:

- Conduct a thermal impact assessment for its solely and jointly owned applicable BES power transformers where the maximum effective GIC value is 75 A per phase or greater.
- Document the thermal impact assessments for its solely and jointly owned applicable BES power transformers in a “Transformer Thermal Impact Assessment Report”.

- Ensure that the analysis conducted in support of thermal impact assessments for its solely and jointly owned applicable BES power transformers is based upon the effective GIC value provided by SPP, as Planning Coordinator (R6.1).
- Ensure that the assumptions used in the analysis conducted in support used in the thermal impact assessment for its solely and jointly owned applicable BES power transformers are documented in the “Transformer Thermal Impact Assessment Report” (R6.2).
- Ensure that suggested actions and the analysis supporting the mitigation of GIC impacts identified in the thermal impact assessment for its solely and jointly owned applicable BES power transformers are documented in the “Transformer Thermal Impact Assessment Report” (R6.3).
- Provide its “Transformer Thermal Impact Assessment Report” for all applicable solely and jointly-owned BES power transformers within the SPP Planning Coordinator area to SPP, as Planning Coordinator, within 24 calendar months of receiving GIC flow information from SPP, as Planning Coordinator (R6.4).
- Provide its “Transformer Thermal Impact Assessment Report” for all applicable solely and jointly-owned BES power transformers within the SPP Planning Coordinator area, to the accountable Transmission Planner, within 24 calendar months of receiving GIC flow information from SPP, as Planning Coordinator (R6.4).

Joint Responsibilities

None.

R7

Requirement R7: Each responsible entity, as determined in Requirement R1, that concludes, through the GMD Vulnerability Assessment conducted in Requirement R4, that their System does not meet the performance requirements of Table 1 shall develop a Corrective Action Plan addressing how the performance requirements will be met.

Individual Responsibilities⁸

SPP, as Planning Coordinator, shall:

- List System deficiencies identified as part of the GMD Vulnerability Assessment in the “GMD Vulnerability Assessment Report” (7.1).
- Ensure that collaboratively developed Corrective Action Plans identified as part of the GMD Vulnerability Assessment are documented in the “GMD Vulnerability Assessment Report”.
- Provide the Corrective Action Plan(s) annotated in the “GMD Vulnerability Assessment Report” to SPP Reliability Coordinator, adjacent Planning Coordinators, adjacent Transmission Planners, functional entities referenced in the Corrective Action Plan(s), and to any functional entity that submits a written request and has a reliability-related need, within 90 calendar days of completion (R7.3). These entities will have 90 calendar days to review and submit their feedback on the “GMD Vulnerability Assessment Report” to SPP Planning Coordinator.
- At the end of the 90-day review period, make a documented response to recipients of Corrective Action Plans annotated in the “GMD Vulnerability Assessment Report” who provide documented comments on the results, within 90 calendar days of SPP, as Planning Coordinator (R7.3.1).

Transmission Planners, within the SPP Planning Coordinator area, shall:

- Provide the Corrective Action Plan(s) annotated in the “GMD Vulnerability Assessment Report” to the Reliability Coordinator(s), adjacent Planning Coordinator(s), or adjacent Transmission Planner(s) for the Facilities which it acts as Transmission Planner (R7.3).
- Provide the Corrective Action Plan(s) annotated in the “GMD Vulnerability Assessment Report” to any functional entity that submits a written request and has a reliability-related need for information related to Facilities which it acts as Transmission Planner, within 90 calendar days of completion (R7.3).

⁸ FERC Order No. 830 directs NERC to revise TPL-007-1 to require deadlines for Corrective Action Plans and GMD mitigating actions. FERC established May 2018 as the deadline for NERC to complete these revisions. Therefore, it is expected that the individual responsibilities of R7 will change in the future, likely necessitating the addition of individual responsibilities for Transmission Owners and Generator Owners.

- Make a documented response to recipients of Corrective Action Plans annotated in the “GMD Vulnerability Assessment Report” who provide documented comments on the results, within 90 calendar days of the Transmission Planner receiving the comments (R7.3.1).

Joint Responsibilities

SPP, as Planning Coordinator, and Transmission Planners, within the SPP Planning Coordinator area, shall:

- Collaboratively develop a Corrective Action Plan(s) to address deficiencies indicated in the GMD Vulnerability Assessment by the inability to meet performance requirements.
- Ensure that the collaboratively developed Corrective Action Plan(s) list actions required to achieve performance requirements (R7.1).
- Ensure that Corrective Action Plans identified as necessary to address the inability to meet performance requirements in prior “GMD Vulnerability Assessment Report” documents are reviewed as part of the GMD Vulnerability Assessment (R7.2).
- Collaboratively develop a response to comments received from SPP Reliability Coordinator, adjacent Planning Coordinators, adjacent Transmission Planners, functional entities referenced in the Corrective Action Plan(s), and to any functional entity that submits a written request and has a reliability-related need about the “GMD Vulnerability Assessment Report”.

Section 2: Standard Application Guidance

THIS SECTION IS INTENDED FOR CONTINUOUS IMPROVEMENT AND IS SUBJECT TO AMENDMENT AS FURTHER EXPERIENCE IS GAINED THROUGH THE PERFORMANCE OF THE INITIAL AND SUBSEQUENT GMD VULNERABILITY ASSESSMENTS.

This section is intended to give guidance on the individual and joint responsibilities annotated in the previous section. The guidance provided in this section complements the responsibilities in accordance with TPL-007-1 and lays out how each functional entity works together towards the successful completion and reporting of GMD Vulnerability Assessments. It is noted that, although the requirements of TPL-007-1 are fixed, the guidance provided in this section is intended to adapt over time. As the knowledge and experience gained by the applicable entities increases, it is intended that this guidance section will likewise be updated and improved. The TPLTF, or group delegated by TWG, is responsible for updating and approving changes to Section 2. The TPLTF, or group delegated by TWG, will review Section 2 periodically, but no less frequently than every 60 months, consistent with the periodicity of GMD Vulnerability Assessments.

R1

The purpose of the “Section 1: Individual and Joint Responsibilities” section of this document is to establish the individual and joint responsibilities for maintaining models and performing the studies needed to complete GMD Vulnerability Assessments. SPP, as Planning Coordinator, in conjunction with SPP member Transmission Planners, meet the requirements of R1 through mutual adoption of this guidance document. Responsibilities for Transmission Owners and Generator Owners integral to the GIC/GMD data collection and study process, likewise, are specified in this guidance document.

R2

SPP, as Planning Coordinator, will maintain the SPP GMD Model Set containing all appropriate TPL-007-1 Requirement R2 GIC System model and System model data used as part of the GMD Vulnerability Assessment⁹. The SPP GMD Model Set will contain the GIC System model, a DC-equivalent representation of the BES that includes all power transformers with a high side, wye-grounded winding with a terminal voltage greater than 200 kV¹⁰, integrated into System models in Siemens/PTI PSS/E 33.7 (or later version) format for the SPP Planning Coordinator area. SPP as Planning Coordinator will request GIC System model updates from each Transmission Planner, Transmission Owner, and Generator Owner within the SPP Planning Coordinator area. System

⁹ TPL-007-1 Requirement R2 specifies two model representations, the System model and the GIC System model. For clarity, a distinction is made between the GIC System model and System model in this guidance document. However, it is typical industry practice to maintain the two model schemas together, as part of the same software-based representation.

¹⁰ Discrete modeling of GIC effects on the power system may rely upon equipment information below the 200kV voltage threshold. SPP, as Planning Coordinator, and Transmission Planners may request data below 200kV, on a case-by-case basis.

model updates are performed under the existing SPP MDWG model building process¹¹ in accordance with the applicable NERC Modeling, Data, and Analysis (MOD) Standards, and are outside the scope of this guidance document. SPP, as Planning Coordinator, meets the requirements of R2 by maintaining a set of two SPP GMD Model Set cases, representing system topology for Year One and Year Five summer peak¹² load from the annual SPP Model Development Working Group (MDWG) approved model series. The rationale for the use of summer peak cases is to ensure that more restrictive ambient temperature Facility Ratings, for entities that use seasonal Facility Ratings, are incorporated into models used for GMD Vulnerability Assessments. Clearly, the objective is to select cases that will produce the most severe thermal and voltage conditions under benchmark GMD event conditions. It will be an on-going effort to ensure that the most appropriate cases are part of the GMD Model Set.

SPP, as Planning Coordinator, will make the SPP GMD Model Set available to all TPL-007-1 applicable Transmission Planners, Transmission Owners, and Generator Owners within the SPP Planning Coordinator area.

Each Transmission Planner within the SPP Planning Coordinator area meets the requirements of R2 by maintaining its respective planning area in the SPP GMD Model Set. Participation in periodic SPP requests for GIC Model data does not preclude the Transmission Planner from maintaining its own planning area System models and GIC System models, nor does this require the Transmission Planner to use the SPP GMD Model Set to perform studies needed to complete its GMD Vulnerability Assessment. However, by submitting the appropriate GIC data to SPP as the Planning Coordinator, and participating in the maintenance of the SPP GMD Model Set, the Transmission Planner meets the requirements of R2 for its planning area.

Transmission Owners and Generator Owners do not typically have planning areas unless they are registered as a planning entity (e.g., Transmission Planner). However, the participation of each Transmission Owner and Generator Owner within the SPP Planning Coordinator area is critical for ensuring that the GIC Model data for their respective equipment is properly maintained in the SPP GMD Model Set. Each Transmission Owner and Generator Owner within the SPP Planning Coordinator area will submit the appropriate GIC data to SPP as the Planning Coordinator and to their respective Transmission Planner, if applicable, in support of the periodic SPP GMD Model Set data request. Data submitted by Transmission Owners and Generator Owners will adhere to the GMD/GIC data request template developed by the TPLTF and be compatible with PSS/E software.

R3

SPP, as Planning Coordinator, will meet the requirements of R3 by establishing criteria for acceptable System steady-state voltage performance within its Planning Coordinator area during the benchmark GMD event described in Attachment 1. These criteria will be developed in conjunction with Transmission Planners within the SPP Planning Coordinator area. SPP, as Planning

¹¹ Coordination with the MDWG will likely be necessary to incorporate data collection requirements into existing model development processes, as well the SPP MDWG Procedure Manual.

¹² Additional cases, such as a shoulder load case, may be of value for benchmark GMD event simulation and analysis, given that the topology is typically identical to peak cases with differing load profiles. The determination of what cases, in addition to the required peak cases, may have value for assessing system effects given a benchmark GMD event will be an on-going process.

Coordinator, will ensure that all Facilities within its Planning Coordinator area have System steady-state voltage performance criteria.

Each Transmission Planner within the SPP Planning Coordinator area will meet the requirements of R3 by adopting the criteria for acceptable System steady-state voltage performance established by the Planning Coordinator. Further, each Transmission Planner will participate in the development of the System steady-state voltage performance criteria, in conjunction with SPP, as Planning Coordinator.

It is well-accepted by industry that transmission equipment loaded above continuous ampacity ratings for extended periods will cause life reduction, regardless if the increased loading is caused by a GMD event or otherwise. Similarly, system equipment will suffer increased stress, possible misoperation, and potential life reduction when transmission voltages deviate outside of continuous equipment voltage ratings. The individual responsibility of Transmission Planners, in accordance with R3, to “adopt” SPP steady-state voltage performance criteria at a minimum is intended to emphasize that existing criteria should not be relaxed simply for benchmark GMD event analysis. If, through the process of study and analysis, a technical basis for modifying steady-state voltage performance criteria for GMD events is identified, changes should be proposed through the standardized SPP criteria change process. Given that the SPP footprint extends from latitudes 32° to 49° North, the effects of GMD events will vary significantly across the SPP Planning Coordinator area. While each applicable entity may have unique needs based upon the GIC effects induced by local geography, geology, and system topologies, the importance of maintaining sufficient steady-state voltage performance criteria is paramount.

SPP, as Planning Coordinator, and Transmission Planners within the Planning Coordinator area will review the established GMD steady-state voltage criteria annually as part of the SPP GMD Model Set data request.

R4

SPP, as Planning Coordinator, and the Transmission Planners meet the requirements of R4 by collaboratively completing periodic GMD Vulnerability Assessments. The SPP, as Planning Coordinator, will coordinate and perform the studies necessary for the GMD Vulnerability Assessment. The Transmission Planners within the SPP Planning Coordinator area will participate in and review the studies necessary for the GMD Vulnerability Assessment. The narrative and the results of the GMD Vulnerability Assessment will be compiled into a “GMD Vulnerability Assessment Report” by SPP, as Planning Coordinator, in collaboration with the Transmission Planners.

The GMD analysis module for Siemens/PTI PSS/E software (versions 33.7 or later) will be used by SPP, as Planning Coordinator, to perform necessary simulations in support the GMD Vulnerability Assessment. Data submitted by all applicable entities will adhere to the GMD/GIC data request template developed by the TPLTF and be compatible with PSS/E software.

R5

The GIC flow information to be used for the transformer thermal impact assessment specified in Requirement R5 will be derived from the SPP GMD Model Set. SPP, as Planning Coordinator, and the Transmission Planners meet the requirements of R5 by providing GIC flow information, based upon load flow results obtained from analysis performed using the SPP GMD Model Set, to each Transmission Owner and Generator Owner that owns an applicable BES power transformer in the SPP Planning Coordinator area.

SPP, as Planning Coordinator, and the Transmission Planners meet the requirements of R5.1 by simulating the worst-case geoelectric field orientation for the benchmark GMD event described in Attachment 1 of TPL-007-1 during study utilizing the SPP GMD Model Set. SPP, as Planning Coordinator, provides the derived maximum effective GIC value flow information, based upon load flow results from the SPP GMD Model Set, to the Transmission Owner or Generator Owner that owns each applicable BES power transformer in the planning area. As the data derived from the SPP GMD Model Set is shared between SPP, as Planning Coordinator, and the Transmission Planners, all GIC flow information that must be provided to Transmission Owners and Generator Owners in accordance with R5.1 will be transmitted by SPP, as Planning Coordinator, copying the applicable Transmission Planner. This assures that GIC flow information is communicated efficiently and consistently, while allowing SPP, as Planning Coordinator, and the Transmission Planners to meet the obligations of R5.1.

As the Planning Coordinator, SPP must be responsive to requests for GIC flow data to be used for the purpose of transformer thermal impact assessment. In accordance with R5.2, when SPP, as Planning Coordinator, receives a written request for effective GIC flow information or time series data for an applicable BES power transformer in the SPP Planning Coordinator area, SPP will respond to the request within 90 calendar days of the inquiry. The GIC time series is calculated from the SPP GMD Model Set, reflecting simulated benchmark GMD event conditions, described in Attachment 1 of TPL-007-1. As the data derived from the SPP GMD Model Set is shared between SPP, as Planning Coordinator, and the Transmission Planners, all GIC flow information that must be provided to Transmission Owners and Generator Owners in accordance with R5.2 will be transmitted by SPP, as Planning Coordinator, copying the applicable Transmission Planner. This assures that effective GIC time series information is communicated efficiently and consistently, while allowing SPP, as Planning Coordinator, and the Transmission Planners to meet the obligations of R5.2.

GIC time series information is presently available from NERC. The NERC dataset provides scaled geoelectric field data based upon calculations made from data measured at the Ottawa Magnetic Observatory on March 13-14, 1989. This legacy data may be insufficient for analysis within the SPP Planning Coordinator area. It is likely that as monitoring of GMD magnitudes, GIC currents, and other GIC-related telemetry increases, that better GIC time series information may be developed, better suited to the SPP Planning Coordinator area. As better data becomes available SPP, as Planning Coordinator, and the Transmission Planners within the Planning Coordinator area may determine GIC time series data sets that are more appropriate to support transformer thermal impact assessments.

R6

Each Transmission Owner and Generator Owner that owns an applicable BES power transformer in the SPP Planning Coordinator area meets the requirements of R6 by conducting a thermal impact assessment for its solely and jointly owned transformers where the maximum effective GIC value is 75A per phase or greater. Each Transmission Owner and Generator Owner will provide results of its transformer thermal impact assessment to SPP, as Planning Coordinator, and each applicable Transmission Planner within 90 days of completion. The data provided will be utilized by SPP, as Planning Coordinator, and the Transmission Planners during development of the GMD Vulnerability Assessment.

R7

SPP, as Planning Coordinator, and the Transmission Planners meet the requirements of R7 by developing Corrective Action Plans when portions of their respective planning areas do not meet the performance requirements of TPL-007-1 Table 1. All Corrective Action Plans, subject to confidentiality restrictions¹³, will be included in the GMD Vulnerability Assessment Report.

SPP, as Planning Coordinator, and the Transmission Planners meet the requirements of R7.1 by ensuring all Corrective Action Plans, developed by SPP, as Planning Coordinator, in collaboration with the Transmission Planners list System deficiencies and the associated actions needed to achieve System performance specified in TPL-007-1 Table 1.

Upon compiling all Corrective Action Plans, the mitigating actions contained within them should be re-simulated to ensure that the GIC effects under GMD benchmark event conditions do not cause the failure to achieve System performance specified in TPL-007-1 Table 1. It is possible that some mitigating actions, such as GIC blocking devices or operating guidance, may correct local adverse GIC effects, but simultaneously exacerbate GIC effect elsewhere in the system. The GMD Vulnerability Assessment study scope should specify the procedure for collaboration to develop Corrective Action Plans, as well as the process by which the mitigating actions are re-simulated to complete the analysis necessary for the GMD Vulnerability Assessment.

SPP, as Planning Coordinator, and the Transmission Planners meet the requirements of R7.2 by reviewing all Corrective Action Plans determined on the prior GMD Vulnerability Assessment during the subsequent GMD Vulnerability Assessment. If a prior Corrective Action Plan is completed, or it is no longer applicable, or it is otherwise shown that the System meets the performance requirements contained in TPL-007-1 Table 1, notes to that effect will be included in the GMD Vulnerability Assessment.

SPP, as Planning Coordinator, and the Transmission Planners meet the requirements of R7.3 by providing the respective Reliability Coordinator, adjacent Planning Coordinator(s), adjacent Transmission Planner(s), and functional entities referenced in the Corrective Action Plan, the applicable Corrective Action Plans subject to confidentiality restrictions, within 90 calendar days of

¹³ Publishing Corrective Action Plans is a sensitive topic and policies vary across the industry. By emphasizing confidentiality restrictions here, the intention is to highlight the importance of making Corrective Action Plans available to entities with valid reliability-related needs, while respecting the proprietary nature of proposed solutions.

completion of the GMD Vulnerability Assessment Report. Similarly, for all written requests not originating from the Reliability Coordinator, adjacent Planning Coordinator(s), adjacent Transmission Planner(s), or functional entities referenced in the Corrective Action Plan, SPP, as Planning Coordinator, and the applicable Transmission Planners will ensure that a reliability-related need is justified prior to releasing Corrective Action Plan information. When a written request is received after the 90 calendar day period following completion of the GMD Vulnerability Assessment Report, SPP as Planning Coordinator, and the applicable Transmission Planner will respond within 30 calendar days.