

A. Introduction

1. **Title:** Transmission System Planning Performance Requirements for Geomagnetic Disturbance (GMD) Events
2. **Number:** MH-TPL-007-2
3. **Purpose:** Establish Transmission system planning performance requirements within the planning horizon to develop Manitoba’s portion of the Bulk Electric System (BES) that will operate reliably during a geomagnetic disturbance Event.
4. **Applicability:**
 - 4.1. **Functional Entities:**
 - 4.1.1. Planning Coordinator;
 - 4.1.2. Transmission Owner; and
 - 4.1.3. Generator Owner.
 - 4.2. **Facilities:**
 - 4.2.1. Facilities that include power transformer(s) with a high side, wye-grounded winding with terminal voltage greater than 200 kV.
5. **Effective Date:** MH-TPL-007-2 shall become effective in Manitoba on July 1, 2018.
6. **Interpretation:** The capitalized terms in MH-TPL-007-2 shall have the meaning set forth in the “Glossary of Terms Used in NERC Reliability Standards” effective July 1, 2018.

B. Requirements

- R1.** *Not Applicable in Manitoba*
- R2.** The Manitoba Hydro (Planning Coordinator) shall maintain System models and geomagnetically induced current (GIC) System models for its respective area for performing the study or studies needed to complete a GMD Vulnerability Assessment.
 - 2.1.** System models shall use data consistent with that provided in accordance with the applicable NERC MOD Reliability Standard(s) and shall represent:
 - 2.1.1.** Existing Facilities;
 - 2.1.2.** New planned Facilities and changes to existing Facilities;
 - 2.1.3.** Real and reactive Load forecasts;
 - 2.1.4.** Resources (supply or demand side) required for Load; and
 - 2.1.5.** Expected increase in transformer reactive power loss as a result of calculated GIC.
 - 2.2.** System models used to calculate GIC shall represent:
 - 2.2.1.** Manitoba earth conductivity and thickness;
 - 2.2.2.** DC resistance of Manitoba's portion of the BES including transmission lines, transformers and station grounding resistance;
 - 2.2.3.** Equivalent DC resistance values representing the neighbouring BES systems in Ontario, Saskatchewan and the U.S.; and
 - 2.2.4.** Magnitude and direction of a uniform geo-electric field source (V/km).
- R3.** The Manitoba Hydro (Planning Coordinator) shall have criteria for acceptable System steady state voltage performance for its System during the GMD events described in Table 1.
- R4.** The Manitoba Hydro (Planning Coordinator) shall complete a GMD Vulnerability Assessment of the Near-Term Transmission Planning Horizon at least 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.
 - 4.1.** The study or studies shall include the following conditions:
 - 4.1.1.** System On-Peak Load for at least one year within the Near-Term Transmission Planning Horizon;
 - 4.1.2.** System Off-Peak Load for at least one year within the Near-Term Transmission Planning Horizon; and
 - 4.1.3.** Geo-electric field directions of 0 degrees (North), 45 degrees, 90 degrees (East), 135 degrees and the geo-electric field direction that produces maximum total absolute value of GIC in Manitoba.

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- 4.2. The study or studies shall be conducted based on the GMD event(s) described in Table 1 to determine whether the System meets the performance requirements in Table 1.
- 4.3. The study or studies shall consider the impact of the suggested actions from the thermal impact assessment performed in R6.3, if available.
- 4.4. If the analysis concludes there is Cascading, voltage collapse or uncontrolled islanding caused by the occurrence of an extreme GMD event defined in Table 1, an evaluation of possible actions designed to reduce the likelihood or mitigate the consequences of the event(s) shall be conducted and included in the GMD Vulnerability Assessment.
- 4.5. If the analysis indicates an inability of the System to meet the performance requirements in Table 1 caused by a GMD planning event defined in Table 1, the GMD Vulnerability Assessment shall include the development of an applicable Corrective Action Plan (CAP) to address the inability of the System to meet the performance requirements. Prior to the implementation of any element of a Corrective Action Plan developed in accordance with this Requirement all applicable corporate, regulatory, provincial, and federal evaluations and approvals must be completed and obtained. During the time period prior to such implementation of an applicable Corrective Action Plan, the Manitoba Hydro (Planning Coordinator) is permitted to use manual or automatic load shedding to correct the situation, notwithstanding the performance requirements in Table 1. The applicable timeline for implementation of a Corrective Action Plan shall be determined by the Manitoba Hydro (Planning Coordinator). The CAP shall list System deficiencies and the associated actions needed to achieve required System performance. Examples of such actions include but are not limited to:
 - 4.5.1. Installation, modification, retirement, or removal of Transmission and generation Facilities and any associated equipment;
 - 4.5.2. Installation, modification, or removal of Protection Systems or Remedial Action Schemes;
 - 4.5.3. Use of Operating Procedures, specifying how long they will be needed as part of the CAP;
 - 4.5.4. Use of Demand-Side Management, new technologies, or other initiatives; and
 - 4.5.5. Use of additional overload capability for multiple Contingency events considering pre-contingency line loading.
- 4.6. The GMD Vulnerability Assessment shall be provided: (i) to the responsible entity's Reliability Coordinator, adjacent Planning Coordinators, and adjacent Transmission Planners within 90 calendar days of completion, and (ii) to any functional entity that submits a written request and has a reliability-related need within 90 calendar days of receipt of such request or within 90 calendar days of completion of the GMD Vulnerability Assessment, whichever is later.
 - 4.6.1. If a recipient of the GMD Vulnerability Assessment provides documented comments on the results, the responsible entity shall provide a documented response to that recipient within 90 calendar days of receipt of those comments.

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- R5.** The Manitoba Hydro (Planning Coordinator) shall provide GIC flow information to be used for the thermal impact assessment of transformers specified in Requirement R6 to each Transmission Owner and Generator Owner that owns an applicable Bulk Electric System (BES) power transformer in the Manitoba Hydro planning area. The GIC flow information shall include:
- 5.1.** The maximum effective GIC value for the worst case geo-electric field orientation for the GMD event(s) described in Table 1.
 - 5.2.** The base GIC value for an average geo-electric field of 1 V/km using the same geo-electric field orientation as defined in R5.1.
- 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. The thermal impact assessment shall:
- 6.1.** Be based on the maximum effective and base GIC values provided in Requirement R5;
 - 6.2.** Document the methodology and assumptions used in the analysis;
 - 6.3.** Describe suggested actions and supporting analysis to mitigate the impact of GICs, if any; and
 - 6.4.** Be performed and provided to the Manitoba Hydro (Planning Coordinator), within 24 calendar months of receiving GIC flow information specified in Requirement R5, Part 5.1.
- R7.** *Not Applicable in Manitoba*
- R8.** *Not Applicable in Manitoba*
- R9.** *Not Applicable in Manitoba*
- R10.** *Not Applicable in Manitoba*
- R11.** *Not Applicable in Manitoba*
- R12.** *Not Applicable in Manitoba*

Table 1: Steady State Performance GMD Events

Steady State:

- a. Voltage collapse, Cascading and uncontrolled islanding shall not occur for a GMD planning event.
- b. Generation loss is acceptable as a consequence of any GMD event.
- c. Planned System adjustments such as Transmission configuration changes and re-dispatch of generation are allowed if such adjustments are executable within the time duration applicable to the Facility Ratings.

Category	Initial Condition	Event	Interruption of Firm Transmission Service Allowed	Non-consequential Load Loss Allowed
GMD Planning Event - GMD Event with Outages	1. System as may be postured in response to space weather information ¹ , and then 2. GMD Planning event ²	Reactive Power compensation devices and other Transmission Facilities ⁵ removed as a result of Protection System operation or Misoperation due to harmonics during the GMD event.	Yes ⁴	Yes
GMD Extreme Event(s) - GMD Event with Outages	1. System as may be postured in response to space weather information ¹ , and then 2. GMD Extreme event ³	Reactive Power compensation devices and other Transmission Facilities ⁵ removed as a result of Protection System operation or Misoperation due to harmonics during the GMD event.	Yes ⁴	Yes ⁶

Table 1: Steady State Performance Footnotes

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1. The System condition for GMD planning may include adjustments to posture the System that are executable in response to space weather information; see Manitoba Hydro's GMD Operating Plan for severe geomagnetic storms (EOP-1324-02).
2. Assume a uniform geo-electric field over the Province of Manitoba with a magnitude of 3V/km.
3. Assume a uniform geo-electric field over the Province of Manitoba with a magnitude i) 3.5V/km and ii) 8V/km.
4. Curtailment of Firm Transmission Service is allowed both as a System adjustment (as identified in the column entitled 'Initial Condition') and a corrective action when achieved through the appropriate re-dispatch of resources obligated to re-dispatch (eg. generator contingency reserves identified in a reserve sharing agreement), where it can be demonstrated that Facilities, internal and external to the Transmission Planner's planning region, remain within applicable Facility Ratings and the re-dispatch does not result in any Non-Consequential Load Loss.
5. Transformer banks with elevated levels of GIC above 75 Amps are assumed to remain connected during the GMD event(s).
6. Non-Consequential Load loss as a result of manual or automatic Load shedding (e.g., UVLS) may be used to meet BES performance requirements during a GMD extreme event. The likelihood and magnitude of Non-Consequential Load loss should be minimized.

C. Measures

- M1.** *Not Applicable in Manitoba*
- M2.** The Manitoba Hydro (Planning Coordinator) shall have evidence in either electronic or hard copy format that it is maintaining System models and GIC System models of their respective planning area for performing the study or studies needed to complete a GMD Vulnerability Assessment.
- M3.** The Manitoba Hydro (Planning Coordinator) shall have evidence, such as electronic or hard copies of the criteria for acceptable System steady state voltage performance for its System in accordance with Requirement R3.
- M4.** The Manitoba Hydro (Planning Coordinator) shall have dated evidence such as electronic or hard copies of its GMD Vulnerability Assessment meeting all of the requirements in Requirement R4. The Manitoba Hydro (Planning Coordinator) shall also provide evidence, such as email records, web postings with an electronic notice of posting, or postal receipts showing recipient and date, that it has distributed its GMD Vulnerability Assessment: (i) to the responsible entity's Reliability Coordinator, adjacent Planning Coordinators, and adjacent Transmission Planners within 90 calendar days of completion, and (ii) to any functional entity that submits a written request and has a reliability-related need within 90 calendar days of receipt of such request or within 90 calendar days of completion of the GMD Vulnerability Assessment, whichever is later, as specified in Requirement R4. The Manitoba Hydro (Planning Coordinator) shall also provide evidence, such as email notices or postal receipts showing recipient and date, that it has provided a documented response to comments received on its GMD Vulnerability Assessment within 90 calendar days of receipt of those comments in accordance with Requirement R4.
- M5.** The Manitoba Hydro (Planning Coordinator) shall provide evidence, such as email records, web postings with an electronic notice of posting, or postal receipts showing recipient and date, that it has provided the maximum effective and base GIC values to the Transmission Owner and Generator Owner that owns each applicable BES power transformer in the Manitoba Hydro planning area as specified in Requirement R5.
- M6.** Each Transmission Owner and Generator Owner shall have evidence such as electronic or hard copies of its thermal impact assessment for all of 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, and shall have evidence such as email records, web postings with an electronic notice of posting, or postal receipts showing recipient and date, that it has provided its thermal impact assessment to the Manitoba Hydro (Planning Coordinator) as specified in Requirement R6.
- M7.** *Not Applicable in Manitoba*
- M8.** *Not Applicable in Manitoba*
- M9.** *Not Applicable in Manitoba*
- M10.** *Not Applicable in Manitoba*
- M11.** *Not Applicable in Manitoba*
- M12.** *Not Applicable in Manitoba*

D. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority

Not applicable.

1.2. Compliance Monitoring Period and Reset Timeframe

Not applicable.

1.3. Compliance Monitoring and Enforcement Processes:

Compliance Audits

Self-Certifications

Spot Checking

Self-Reporting

Complaints

1.4. Data Retention

The Manitoba Hydro (Planning Coordinator) shall keep data or evidence to show compliance as identified:

- For Requirements R2, R3, R5, and R6.4 documentation shall be retained as evidence for five years.
- For Requirements R4, documentation of the current GMD Vulnerability Assessment and the preceding GMD Vulnerability Assessment shall be retained as evidence.

1.5. Additional Compliance Information

None.

E. Regional Variances

None.

F. Associated Documents

None.

G. Version History

None.