

Agenda

Project 2013-03 Geomagnetic Disturbance Mitigation Standard Drafting Team Meeting

February 16, 2017 | 2:30 p.m. - 3:45 p.m. Eastern

[Join WebEx Meeting](#) | Meeting / Access Code: 731 660 682

Dial-in: 1-415-655-0002 (US Toll) | 1-416-915-8942 (Canada Toll) | Enter Access Code: 738 370 131

NERC Antitrust Compliance Guidelines and Public Announcement

Agenda Items

1. Chair's Remarks
2. Introductions
3. Review Standards Authorization Request (SAR) comments, proposed responses, and revisions to project SAR*
4. Review draft TPL-007-2 Requirement R7 addressing Corrective Action Plan directives (Order No. 830 P 101-103)*
5. Status update on addressing other project directives
6. Discuss meeting objectives and details for February in-person meeting
7. Future Meetings
 - a. February 21-22 (GMD Task Force) | EPRI, Charlotte North Carolina
 - b. February 27 - March 1 | ERCOT, Austin Texas
 - i. Meeting starts at 1 p.m. central on Feb 27 and concludes by noon on March 1

*Background materials attached

Consideration of Comments

Project Name: 2013-03 Geomagnetic Disturbance Mitigation SAR
Comment Period Start Date: 12/16/2016
Comment Period End Date: 1/20/2017

There were 21 sets of responses, including comments from approximately 21 different people from approximately 19 companies representing 8 of the Industry Segments as shown in the table on the following pages.

All comments submitted can be reviewed in their original format on the [project page](#).

If you feel that your comment has been overlooked, please let us know immediately. Our goal is to give every comment serious consideration in this process. If you feel there has been an error or omission, you can contact the Director of Standards Development, [Steve Noess](#) (via email) or at (404) 446-9691.

Questions

- 1. Do you agree with the proposed scope for Project 2013-03 as described in the SAR? If you do not agree, or if you agree but have comments or suggestions for the project scope please provide your recommendation and explanation.**
- 2. Provide any additional comments for the Standards Drafting Team (SDT) to consider, if desired.**

The Industry Segments are:

- 1 — Transmission Owners
- 2 — RTOs, ISOs
- 3 — Load-serving Entities
- 4 — Transmission-dependent Utilities
- 5 — Electric Generators
- 6 — Electricity Brokers, Aggregators, and Marketers
- 7 — Large Electricity End Users
- 8 — Small Electricity End Users
- 9 — Federal, State, Provincial Regulatory or other Government Entities
- 10 — Regional Reliability Organizations, Regional Entities

Organization Name	Name	Segment(s)	Region	Group Name	Group Member Name	Group Member Organization	Group Member Segment(s)	Group Member Region
ACES Power Marketing	Brian Van Gheem	6	NA - Not Applicable	ACES Standards Collaborators	Bob Solomon	Hoosier Energy Rural Electric Cooperative, Inc.	1	RF
					Karl Kohlrus	Prairie Power, Inc.	1,3	SERC
					Shari Heino	Brazos Electric Power Cooperative, Inc.	1,5	Texas RE
					Tara Lightner	Sunflower Electric Power Corporation	1	SPP RE
					Mark Ringhausen	Old Dominion Electric Cooperative	3,4	SERC
					John Shaver	Arizona Electric Power Cooperative, Inc.	1	WECC
					Bill Hutchison	Southern Illinois Power Cooperative	1	SERC

					Scott Brame	North Carolina Electric Membership Corporation	3,4,5	SERC
					Bill Hutchison	Southern Illinois Power Cooperative	1,4	RF
					Bill Hutchison	Southern Illinois Power Cooperative	1,4	RF
Duke Energy	Colby Bellville	1,3,5,6	FRCC,RF,SERC	Duke Energy	Doug Hils	Duke Energy	1	RF
					Lee Schuster	Duke Energy	3	FRCC
					Dale Goodwine	Duke Energy	5	SERC
					Greg Cecil	Duke Energy	6	RF
Seattle City Light	Ginette Lacasse	1,3,4,5,6	WECC	Seattle City Light Ballot Body	Pawel Krupa	Seattle City Light	1	WECC
					Hao Li	Seattle City Light	4	WECC
					Bud (Charles) Freeman	Seattle City Light	6	WECC
					Mike Haynes	Seattle City Light	5	WECC
					Michael Watkins	Seattle City Light	1,4	WECC
					Faz Kasraie	Seattle City Light	5	WECC

					John Clark	Seattle City Light	6	WECC
					Tuan Tran	Seattle City Light	3	WECC
					Laurrie Hammack	Seattle City Light	3	WECC
Southern Company - Southern Company Services, Inc.	Marsha Morgan	1,3,5,6	SERC	Southern Company	Katherine Prewitt	Southern Company Services, Inc	1	SERC
					Jennifer Sykes	Southern Company Generation and Energy Marketing	6	SERC
					R Scott Moore	Alabama Power Company	3	SERC
					William Shultz	Southern Company Generation	5	SERC
Lower Colorado River Authority	Michael Shaw	1,5,6		LCRA Compliance	Teresa Cantwell	LCRA	1	Texas RE
					Dixie Wells	LCRA	5	Texas RE
					Michael Shaw	LCRA	6	Texas RE
Northeast Power Coordinating Council	Ruida Shu	1,2,3,4,5,6,7,10	NPCC	RSC no Dominion and OPG	Paul Malozewski	Hydro One.	1	NPCC
					Guy Zito	Northeast Power	NA - Not Applicable	NPCC

	Coordinating Council		
Randy MacDonald	New Brunswick Power	2	NPCC
Wayne Sipperly	New York Power Authority	4	NPCC
Glen Smith	Entergy Services	4	NPCC
Brian Robinson	Utility Services	5	NPCC
Bruce Metruck	New York Power Authority	6	NPCC
Alan Adamson	New York State Reliability Council	7	NPCC
Edward Bedder	Orange & Rockland Utilities	1	NPCC
David Burke	UI	3	NPCC
Michele Tondalo	UI	1	NPCC
Sylvain Clermont	Hydro Quebec	1	NPCC
Si Truc Phan	Hydro Quebec	2	NPCC

					Helen Lainis	IESO	2	NPCC
					Laura Mcleod	NB Power	1	NPCC
					Michael Forte	Con Edison	1	NPCC
					Quintin Lee	Eversource Energy	1	NPCC
					Kelly Silver	Con Edison	3	NPCC
					Peter Yost	Con Edison	4	NPCC
					Brian O'Boyle	Con Edison	5	NPCC
					Greg Campoli	NY-ISO	2	NPCC
					Kathleen Goodman	ISO-NE	2	NPCC
					Silvia Parada Mitchell	NextEra Energy, LLC	4	NPCC
					Michael Schiavone	National Grid	1	NPCC
					Michael Jones	National Grid	3	NPCC
Midwest Reliability Organization	Russel Mountjoy	10		MRO NSRF	Joseph DePoorter	Madison Gas & Electric	3,4,5,6	MRO
					Larry Heckert	Alliant Energy	4	MRO
					Amy Casucelli	Xcel Energy	1,3,5,6	MRO
					Chuck Lawrence	American Transmission Company	1	MRO
					Michael Brytowski	Great River Energy	1,3,5,6	MRO

					Jodi Jensen	Western Area Power Administratino	1,6	MRO
					Kayleigh Wilkerson	Lincoln Electric System	1,3,5,6	MRO
					Mahmood Safi	Omaha Public Power District	1,3,5,6	MRO
					Brad Parret	Minnesota Power	1,5	MRO
					Terry Harbour	MidAmerican Energy Company	1,3	MRO
					Tom Breene	Wisconsin Public Service	3,5,6	MRO
					Jeremy Volls	Basin Electric Power Coop	1	MRO
					Kevin Lyons	Central Iowa Power Cooperative	1	MRO
					Mike Morrow	Midcontinent Independent System Operator	2	MRO
Southwest Power Pool, Inc. (RTO)	Shannon Mickens	2	SPP RE	SPP Standards	Shannon Mickens	Southwest Power Pool Inc.	2	SPP RE

				Review Group	James Nail	Independence Power and Light	3	SPP RE
					Allan George	Sunflower Electric Power Corp	1	SPP RE
					Jonathan Hayes	Southwest Power Pool Inc.	2	SPP RE

1. Do you agree with the proposed scope for Project 2013-03 as described in the SAR? If you do not agree, or if you agree but have comments or suggestions for the project scope please provide your recommendation and explanation.

David Jendras - Ameren - Ameren Services - 1,3,6

Answer

No

Document Name

Comment

The proposed revision to standard TPL-007-1 to address localized peaks in GMD events and not rely solely on the spatially-averaged data has the potential to impact much more of the transmission system and many more EHV Y-connected transformers than we had previously estimated. It is unknown at this time how the SDT will modify the standard to include this FERC mandated revision, but this would be a major concern for TOs.

It appears that Ameren as a TO will be required to install GIC monitoring equipment and magnetometers, collect data from these devices, and make the data available to those that have a need for the information. Details are still to be determined by the SDT, with the cost to install such equipment and maintain data is unknown.

Although the FERC directive allows for TOs to apply for an exemption to collect necessary GIC monitoring data, exemption criteria has not been proposed to determine if the exemption would or would not be allowed in a particular case. Regardless, because of our location in the Midwest and because of the number of 345 kV lines and EHV Y-connected transformers connected to the Ameren system, it is unlikely that Ameren would be allowed an exemption from installing monitoring equipment and collecting the GIC data, regardless of our southerly location in relation to the geomagnetic north pole.

Due to the fact that FERC is mandating these modifications, we are concerned that input from industry on the drafting of the revised standard would be given minimal consideration.

Likes 0

Dislikes 0

Response. Thank you for your comments. In order to address the FERC Order No. 830 directives, the SDT will consider ways to incorporate localized peak events into the existing GMD benchmark. -It is too soon to know how the benchmark will change and what the impact on the industry will be. Regarding the installation of GIC monitors and magnetometers the SDT intends to coordinate technical details with the NERC GMD Task Force_[MO1]. There is significant industry experience on the SDT, so any requirements that are added to the standard will be thoroughly discussed within the SDT and with the NERC GMD Task Force. Stakeholder input will be considered by the SDT throughout the standard development process.

Russel Mountjoy - Midwest Reliability Organization - 10, Group Name MRO NSRF

Answer Yes

Document Name

Comment

The NSRF agrees with the proposed scope for Project 2013-03 SAR but would like to make several suggestions that will benefit the reliable operation of the BES. If the standard drafting team plans to incorporate real-time reliability monitoring and analysis to satisfy the GMD monitoring requirements, we suggest the SDT add Transmission Operator (TOP) as an applicable Reliability Function in the SAR.

Rationale

FERC gives NERC the option to incorporate the GMD monitoring data collection in another reliability standard. The TOP is the responsible entity to complete real-time reliability monitoring.

“NERC may also propose to incorporate the GIC monitoring and magnetometer data collection requirements in a different Reliability Standard (e.g., real-time reliability monitoring and analysis capabilities as part of the TOP Reliability Standards).” (FERC Order 830, P.91) .

Likes 0

Dislikes 0

Response. Thank you for your comments. Order No. 830 directs NERC to address the collection of data from GIC detectors and magnetometers for the purpose of aiding in the validation of models used to facilitate the calculations required in TPL-007. It does not require real time data collection, but that doesn't limit entities from collecting real time data in support of system operations. If an entity's

operating procedure requires real time data collection, then that process would be documented in procedures under EOP-010 and the TOP would be an applicable entity.

Aaron Cavanaugh - Bonneville Power Administration - 1,3,5,6 - WECC

Answer	Yes
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Document Name	
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Comment

BPA would like to know if the model validation encompasses equipment and system models for accurate GIC current determination (like transformer behavior). BPA would also like to know if the model validation encompass hysteresis curves for VAR consumption determination? BPA believes the model should contain both.

Likes	0
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Dislikes	0
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Response. Thank you for your comments. Order No. 830 is not prescriptive regarding what kind of models would be validated using GIC and/or geomagnetic field measurements. The SDT believes the requirements should be application-neutral.

Ginette Lacasse - Seattle City Light - 1,3,4,5,6 - WECC, Group Name Seattle City Light Ballot Body

Answer	Yes
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Document Name	
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Comment

Our subject matter experts do not believe that collected data should be available to the public. Or clearly define what is meant by "publicly available" and what specifically can be available.

Likes	0
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Dislikes	0
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Response. Thank you for your comment. Order No. 830 is clear in directing NERC to require entities to collect GIC and magnetometer data, and for NERC to make the data publically available. The details of such a program are yet to be worked out, but will include discussions among the SDT, the NERC GMD Task Force, and NERC. In Order No. 830, FERC indicated that they were not persuaded by arguments in the record for TPL-007-1 that this data should be treated as confidential, but that entities could seek confidential treatment of their data from NERC (P 94-95). Accordingly, NERC's data collection process developed to meet Order No. 830 is expected to provide entities with the means for identifying some or all data that the entity believes should be treated as confidential.

Brian Van Gheem - ACES Power Marketing - 6 - NA - Not Applicable, Group Name ACES Standards Collaborators

Answer	Yes
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Document Name	
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Comment

(1) We believe the proposed scope captures the directives identified in FERC Order No. 830. However, we believe several references to the FERC Order are taken out of context, and should be removed from the SAR's Detailed Description Section. The Commission wants GIC monitoring and magnetometer data to be gathered through collaboration with academia and government agencies. The reference to include "...any device that must be added..." could misdirect the SDT from the Commission's intentions. We recommend the removal of this particular reference to limit the scope of data collection.

(2) We feel the FERC directive references should be mapped to existing requirements to identify proposed changes. For example, we recommend adding a reference to Requirement R3 when listing the directives associated with Benchmark Events. Likewise, when listing directives for Transformer Thermal Impact Assessment or Corrective Action Plans, Requirement R6 and Requirement R7 should be included as references, respectively.

(3) We question the addition of a reference to move the data collection of GIC monitoring and magnetometer data to a different Reliability Standard. We feel this inclusion opens the door to a Commission suggestion to incorporate data collection as part of real-time reliability monitoring and analysis and relocated to the TOP Reliability Standards. We feel that if such data was required for real-time operations, it likely would have been incorporated in NERC Reliability Standard EOP-010-1, as part of emergency Geomagnetic Disturbance Operations. We recommend the removal of this reference to focus the scope of this project on TPL-007.

(4) The SAR briefly lists the development of an implementation plan, although does not elaborate on what may change within the SAR's Detailed Description Section. While the current five year implementation plan takes effect starting July 2017, we feel a significant portion of

the implementation plan will pass by the time the Commission approves the work of this SDT. We recommend the addition of a reference within the SAR’s Detailed Description Section to incorporate modifications to the implementation plan that accounts for the transition away from the current implementation plane. We believe the transition period should not be less than 18 months to accommodate an impacted entity’s effort to implement modeling and software changes, additional resource procurements, and quality assurance of assessments.

Likes 0

Dislikes 0

Response. Thank you for your comments.

- (1) The FERC order discusses the option of collaborating with academia and government agencies for the collection of data, but that is not the only option provided in the order. It is understood that additional GIC detectors and magnetometers may be required and the SAR accounts for this additional option.
- (2) References to the existing standard requirements will be added as minor editorial remarks.
- (3) The SAR statement on the possibility of placing data collection requirements in another standard is from the FERC order. (paragraph 91)
- (4) It is too soon to know what additional requirements may be placed on applicable entities as a result of modifications to the existing standard. Accordingly, any statements about changes to the implementation plan are premature. The SDT believes the SAR as written provides the necessary project scope for developing an implementation plan.

Ruida Shu - Northeast Power Coordinating Council - 1,2,3,4,5,6,7,10 - NPCC, Group Name RSC no Dominion and OPG

Answer

Yes

Document Name

Comment

NPCC RSC support the proposed scope for Project 2013-03.

Likes 0

Dislikes 0

Response. Thank you for your comment.

Karie Barczak - DTE Energy - Detroit Edison Company - 3,4,5

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Jeffrey DePriest - DTE Energy - Detroit Edison Company - 3,4,5

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Tho Tran - Oncor Electric Delivery - 1 - Texas RE

Answer Yes

Document Name

Comment

Likes 0	
Dislikes 0	
Response	
Sean Bodkin - Dominion - Dominion Resources, Inc. - 3,5,6	
Answer	Yes
Document Name	
Comment	
Likes 0	
Dislikes 0	
Response	
RoLynda Shumpert - SCANA - South Carolina Electric and Gas Co. - 1,3,5,6 - SERC	
Answer	Yes
Document Name	
Comment	
Likes 0	
Dislikes 0	
Response	
Thomas Foltz - AEP - 3,5	

Answer	Yes
Document Name	
Comment	
Likes 0	
Dislikes 0	
Response	
Laura Nelson - IDACORP - Idaho Power Company - 1	
Answer	Yes
Document Name	
Comment	
Likes 0	
Dislikes 0	
Response	
John Merrell - Tacoma Public Utilities (Tacoma, WA) - 1,3,4,5,6	
Answer	Yes
Document Name	
Comment	
Likes 0	
Dislikes 0	

Response

Colby Bellville - Duke Energy - 1,3,5,6 - FRCC,SERC,RF, Group Name Duke Energy

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Shannon Mickens - Southwest Power Pool, Inc. (RTO) - 2 - SPP RE, Group Name SPP Standards Review Group

Answer Yes

Document Name

Comment

Likes 0

Dislikes 0

Response

Rachel Coyne - Texas Reliability Entity, Inc. - 10

Answer Yes

Document Name

Comment

Likes	0
Dislikes	0
Response	
Teresa Cantwell - Lower Colorado River Authority - 1,5,6	
Answer	Yes
Document Name	
Comment	
Likes	0
Dislikes	0
Response	
Michael Shaw - Lower Colorado River Authority - 1,5,6, Group Name LCRA Compliance	
Answer	
Document Name	2013-03_GMD_SAR_Unofficial_Comment_Form_121516.docx
Comment	
Likes	0
Dislikes	0
Response	

2. Provide any additional comments for the Standards Drafting Team (SDT) to consider, if desired.

Brian Van Gheem - ACES Power Marketing - 6 - NA - Not Applicable, Group Name ACES Standards Collaborators

Answer

Document Name

Comment

(1) We believe the SDT should collaborate its activities with existing industry technical groups, including the NERC Geomagnetic Disturbance Task Force, when designing GIC monitoring and magnetometer data collection criteria. We propose limiting the focus of this SAR to GIC monitoring and magnetometer data collection, and allow NERC and these other groups to address how such data will be shared publicly. We fear the SDT's involvement with the distribution of data could lead to unnecessary development of new Reliability Standards for currently unregistered entities and functions.

(2) We thank you for this opportunity to provide these comments.

Likes 0

Dislikes 0

Response. Thank you for your comment. The SDT agrees that NERC and other technical groups such as the NERC GMD Task Force and the Planning Committee should address issues with the public availability of collected data. The SDT is focused on developing requirements for the collection of data as specified in Order No. 830 P 88 and P 91. The SDT has clarified this in the project SAR. The process for the distribution of that data will likely be addressed outside of the revised standard.

Teresa Cantwell - Lower Colorado River Authority - 1,5,6

Answer

Document Name

Comment

The approach related to the GMD benchmark definition and transformer thermal impact assessment needs to balance ease of implementation with the quality of results.

A methodology similar to that employed in PRC-002 should be utilized to limit the required number of installations of monitoring data (e.g. based on short circuit MVA or some other parameter). Not every TO should be required to install monitoring data. This may be better accomplished by rolling the monitoring requirement into another standard (e.g. PRC-002).

NERC should consider extensions of time for CAPs and/or hardware installation on a case-by-case basis.

Likes 0

Dislikes 0

Response. Thank you for your comment. The SDT will consider these inputs during standard development. The SDT believes that there is a balance between ease of implementation and a conservative approach to potential transformer impact by means of the transformer thermal screening criteria.

The SDT will work in conjunction with the NERC GMD Task Force and other industry technical groups in the development of criteria for number and/or location of monitoring equipment. [MO2]

Rachel Coyne - Texas Reliability Entity, Inc. - 10

Answer

Document Name

Comment

Texas RE made the following observations:

- Paragraph 91 in Order No. 830 discusses the ability for a Transmission Owner to apply for an exemption. Texas RE is concerned if the responsible entity determined in R1 is allowed to grant exemptions, many entities that are registered as a TP and TO will be able to

grant itself an exemption. Texas RE recommends determining who is responsible for granting exemptions, since Order No. 830 does not specify.

- The “Industry Need” section includes details about NERC making GMD-related data publicly available, but “Detailed Description” section does not.
- In the “Collection of GMD Data” section, the SAR states that “Each responsible entity that is a transmission owner should be required to collect necessary GIC monitoring data.” However, TPL-007-1 R1 currently defines a “responsible entity” as either a TP or a PC. When updating the Standard, the SDT should avoid using “responsible entity” when referencing a TO.
- Texas RE recommends emphasizing sufficient and appropriate compliance documentation, regarding an “equally efficient and effective alternative”. An entity would be required to demonstrate efficiency and effectiveness. For the data submittal portion, there needs to be care in addressing timing as the directive included historical and new data. There is no discussion of data requirements, per se, and the content, format, or timing associated with the data.

Likes 0

Dislikes 0

Response. Thank you for your comments.

Order No. 830 states that entities should be able to apply for exemption from data collection requirements if an entity “demonstrates that no or little value would be added to planning and operations.” The order provides flexibility for the SDT to establish the process and criteria for requesting and approving such exemptions. The SDT will be discussing the exemption process as part of its work on the revised standard.

The detailed description section of the SAR contains excerpts from the FERC order with a reference to the applicable paragraph in the order. The SDT believes that it is sufficiently clear that the intent is to make the data publicly available

The SDT will make every attempt to provide clarity as to the applicability of the requirements of the standard and will minimize the use of the term “responsible entity”.

The requirements for the collection and distribution of GIC detector and magnetometer data will be developed by the SDT. The FERC order does require both historical and new data to be provided, however historical data will be collected by NERC via a Rules of Procedure Section

1600 data request (not in scope for the standards project). The SDT does not view the Order No. 830 phrase "equally efficient and effective" to apply to compliance documentation.

Shannon Mickens - Southwest Power Pool, Inc. (RTO) - 2 - SPP RE, Group Name SPP Standards Review Group

Answer

Document Name

Comment

After reviewing the transcript associated with the Level 2 Appeal of Foundation For Resilient Societies, INC. in reference to TPL-007-1, we suggest the drafting team review and use this document as guidance throughout their modification process to the Standard. In our review, we found some similarities of concerns shared by both **The Foundation for Resilient Societies, INC** and **FERC Order 830** such as, transformer thermal impact assessments as well as data collection and how that information would be made publicly available.

Likes 0

Dislikes 0

Response. Thank you for your comments. The SDT is aware of Level 2 Appeal transcript. The SDT responded to comments raised by the Foundation for Resilient Societies during development of TPL-007-1.

Ginette Lacasse - Seattle City Light - 1,3,4,5,6 - WECC, Group Name Seattle City Light Ballot Body

Answer

Document Name

Comment

Thank you for seeking our input in advance.

Likes 0

Dislikes 0

Response

Marsha Morgan - Southern Company - Southern Company Services, Inc. - 1,3,5,6 - SERC, Group Name Southern Company

Answer

Document Name

Comment

Because commercially available models and tools do not currently exist for performing transformer thermal impact assessments, we ask the SDT to continue considering suitable alternates (e.g., look up tables, development of flowcharts or processes).

Also, we ask the SDT to provide clarification of the event included in Table 1 - Steady State Planning Events. In particular, with regards to protection system misoperation due to harmonics during a GMD event, please provide clarification as to what is expected. Will this require that large scale harmonic penetration studies be performed in order to analyze potential impact of half-cycle saturation generated harmonics on system protection and/or equipment controls? Or will engineering assessments that identify credible scenarios be sufficient?

SDT to consider that the procurement and installation of instrument transformers for the collection of GIC monitoring and magnetometer data takes months to implement. SDT to consider realistic timelines for implementation, as well as providing technical guidance for implementation of GIC measurement devices.

We ask the SDT to provide additional clarification on R2. In particular, SDT to elaborate on "maintaining System models and GIC System Models." Is R2 referring to gathering and maintaining dc and ac models (e.g., substation dc resistances, dc network data) of the system under study? Does it require having to complete a GIC analysis by R2 deadline, so that GIC system models can be produced and maintained? Please provide clarification.

Likes 0

Dislikes 0

Response. Thank you for your comments. The SDT has provided alternatives for conducting the transformer thermal impact assessments in the original standard and intends to continue in that mode for any modifications that may be necessary to address the FERC directives.

The SDT recognizes that detailed harmonic analyses may be beyond the capability of many applicable entities. As stated in the development of TPL-007-1, reasonable engineering judgment can be exercised to identify protection equipment that may be vulnerable to misoperation in the Benchmark GMD event and therefore, should be outaged in the power flow analysis. (See Project 2013-03 Consideration of Comments dated December 5, 2014, P. 16, P. 48)

To the degree that additional GIC detectors and/or magnetometers are necessary to be installed, the SDT will address the timeframe to install such devices in the implementation plan.

The intent of requirement R2 in TPL-007-1 is to require entities to maintain models necessary to perform the required analysis (both ac models for the network analysis and dc models for the GIC calculation). Requirement R2 does not specify that GIC calculations must be completed.

The SDT will consider providing clarification to the wording of R2.^[MO3]

David Jendras - Ameren - Ameren Services - 1,3,6

Answer

Document Name

Comment

The change in deadlines for mitigation of GMD events would not be a concern in Ameren's case. Ameren is not interested in installing blocking devices to Y-connected EHV transformers. Therefore, operational solutions will provide the likely mitigations.

Likes 0

Dislikes 0

Response Thank you for the comment.

Aaron Cavanaugh - Bonneville Power Administration - 1,3,5,6 - WECC

Answer

Document Name

Comment

BPA would like to know how the Standard Drafting Team envisions collecting the data to perform the studies. If there is no regional data collection effort similar to MOD-032, then how is it envisioned that accurate GIC studies to determine DC currents will be run? BPA believes a documented process needs to be created WECC wide (or nationally). BPA envisions the data collection included with MOD-032 to be collected every 5 years (or according to study schedule with version 2 of TPL-007). BPA’s experience is that most entities are not willing to take on extra work if they do not have to.

Likes 0

Dislikes 0

Response. Thank you for your comment. As noted in development of TPL-007-1, the standard provides flexibility for various approaches to collecting the necessary data for GMD Vulnerability Assessments, including the use of regional planning groups. (See Project 2013-03 Consideration of Comments dated October 28, 2014, P. 23). The whitepapers associated with the development of TPL-007-1 address the process of performing the GIC calculations.

Russel Mountjoy - Midwest Reliability Organization - 10, Group Name MRO NSRF

Answer

Document Name

Comment

None

Likes 0

Dislikes 0

Response

Sandra Shaffer - Berkshire Hathaway - PacifiCorp - 6

Answer

Document Name

Comment

PacifiCorp supports the proposal to incorporate the GIC monitoring and magnetometer data collection requirements in a different Reliability Standard. This separation would allow more attention to the specific upgrades already outlined in the SAR.

Likes 0

Dislikes 0

Response. The SDT will develop the GIC monitoring and magnetometer data collection requirements and determine the most appropriate location for those requirements.

Jeffrey DePriest - DTE Energy - Detroit Edison Company - 3,4,5

Answer

Document Name

Comment

Please consider an approach where GIC monitor locations are determined on a regional basis in order to obtain the most value from each installation and insure that all areas are covered appropriately. An individual GO/TO may not have the information needed to properly place equipment. Also, providing monitoring equipment specifications would insure that manufacturers would design, and entities would install, capable monitors that will provide reliable data.

Likes 0

Dislikes 0

Response. The SDT will develop the GIC monitoring and magnetometer data collection requirements and determine the most appropriate location for those requirements. The SDT will work with the NERC GMD Task Force on the issue of equipment specifications.

Karie Barczak - DTE Energy - Detroit Edison Company - 3,4,5

Answer

Document Name

Comment

Please consider an approach where GIC monitor locations are determined on a regional basis in order to obtain the most value from each installation and insure that all areas are covered appropriately. An individual GO/TO may not have the information needed to properly place equipment. Also, providing monitoring equipment specifications would insure that manufacturers would design, and entities would install, capable monitors that will provide reliable data.

Likes 0

Dislikes 0

Response. The SDT will develop the GIC monitoring and magnetometer data collection requirements and determine the most appropriate location for those requirements. The SDT will work with the NERC GMD Task Force on the issue of equipment specifications

Michael Shaw - Lower Colorado River Authority - 1,5,6, Group Name LCRA Compliance

Answer

Document Name

Comment

Likes 0

Dislikes 0

Response

A. Introduction

1. **Title:** Transmission System Planned Performance for Geomagnetic Disturbance Events
2. **Number:** TPL-007-~~4~~2
3. **Purpose:** Establish requirements for Transmission system planned performance during geomagnetic disturbance (GMD) events.
4. **Applicability:**
 - 4.1. **Functional Entities:**
 - 4.1.1 Planning Coordinator with a planning area that includes a Facility or Facilities specified in 4.2;
 - 4.1.2 Transmission Planner with a planning area that includes a Facility or Facilities specified in 4.2;
 - 4.1.3 Transmission Owner who owns a Facility or Facilities specified in 4.2;
 - 4.1.4 Generator Owner who owns a Facility or Facilities specified in 4.2.
 - 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. **Background:**

During 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.
6. **Effective Date:**

See Implementation Plan for TPL-007-1

B. Requirements and Measures

- 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).
[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]
- M1.** Each Planning Coordinator, in conjunction with its Transmission Planners, shall provide documentation on roles and responsibilities, such as meeting minutes, agreements, copies of procedures or protocols in effect between entities or between departments of a vertically integrated system, or email correspondence that identifies an agreement has been reached on individual and joint responsibilities for maintaining models and

performing the study or studies needed to complete GMD Vulnerability Assessment(s), in accordance with Requirement R1.

- 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). *[Violation Risk Factor: High] [Time Horizon: Long-term Planning]*
- M2.** Each responsible entity, as determined in Requirement R1, shall have evidence in either electronic or hard copy format that it is maintaining 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).
- 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. *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*
- M3.** Each responsible entity, as determined in Requirement R1, 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.
- 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. *[Violation Risk Factor: High] [Time Horizon: Long-term Planning]*
 - 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; and
 - 4.1.2.** System Off-Peak Load for at least one year within the Near-Term Transmission Planning Horizon.
 - 4.2.** The study or studies shall be conducted based on the benchmark GMD event described in Attachment 1 to determine whether the System meets the performance requirements in Table 1.
 - 4.3.** The GMD Vulnerability Assessment shall be provided within 90 calendar days of completion to the responsible entity's Reliability Coordinator, adjacent Planning Coordinators, adjacent Transmission Planners, and to any functional entity that submits a written request and has a reliability-related need.
 - 4.3.1.** 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.

- M4.** Each responsible entity, as determined in Requirement R1, shall have dated evidence such as electronic or hard copies of its GMD Vulnerability Assessment meeting all of the requirements in Requirement R4. Each responsible entity, as determined in Requirement R1, 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 within 90 calendar days of completion to its Reliability Coordinator, adjacent Planning Coordinator(s), adjacent Transmission Planner(s), and to any functional entity who has submitted a written request and has a reliability-related need as specified in Requirement R4. Each responsible entity, as determined in Requirement R1, 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.
- 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. The GIC flow information shall include: *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*
- 5.1.** The maximum effective GIC value for the worst case geoelectric field orientation for the benchmark GMD event described in Attachment 1. This value shall be provided to the Transmission Owner or Generator Owner that owns each applicable BES power transformer in the planning area.
- 5.2.** The effective GIC time series, GIC(t), calculated using the benchmark GMD event described in Attachment 1 in response to a written request from the Transmission Owner or Generator Owner that owns an applicable BES power transformer in the planning area. GIC(t) shall be provided within 90 calendar days of receipt of the written request and after determination of the maximum effective GIC value in Part 5.1.
- M5.** Each responsible entity, as determined in Requirement R1, 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 GIC value to the Transmission Owner and Generator Owner that owns each applicable BES power transformer in the planning area as specified in Requirement R5, Part 5.1. Each responsible entity, as determined in Requirement R1, 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 provided GIC(t) in response to a written request from the Transmission Owner or Generator Owner that owns an applicable BES power transformer in the planning area.

- 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: *[Violation Risk Factor: Medium]* *[Time Horizon: Long-term Planning]*
- 6.1.** Be based on the effective GIC flow information provided in Requirement R5;
 - 6.2.** Document 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 responsible entities, as determined in Requirement R1, within 24 calendar months of receiving GIC flow information specified in Requirement R5, Part 5.1.
- 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 responsible entities as specified in Requirement R6.
- 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. The Corrective Action Plan shall: *[Violation Risk Factor: High]* *[Time Horizon: Long-term Planning]*
- 7.1.** List System deficiencies and the associated actions needed to achieve required System performance. Examples of such actions include:
 - Installation, modification, retirement, or removal of Transmission and generation Facilities and any associated equipment.
 - Installation, modification, or removal of Protection Systems or Special Protection Systems.
 - Use of Operating Procedures, specifying how long they will be needed as part of the Corrective Action Plan.
 - Use of Demand-Side Management, new technologies, or other initiatives.
 - 7.2.** Be developed within one year of completion of the GMD Vulnerability Assessment.
 - 7.3.** Include a timetable for implementing the selected actions from Part 7.1. The timetable shall:

7.3.1. Specify implementation of non-hardware mitigation, if any, within two years of development of the Corrective Action Plan;

7.3.2. Specify implementation of hardware mitigation, if any, within four years of development of the Corrective Action Plan;

7.4. Be revised, when necessary, to document actions taken by the Responsible Entity to address circumstances outside the Responsible Entity's control that prevent the implementation of actions according to the timetable in Part 7.3.[MO1]

7.2.7.5. Be reviewed in subsequent GMD Vulnerability Assessments until it is determined that the System meets the performance requirements contained in Table 1.

7.3.7.6. Be provided within 90 calendar days of ~~completion~~ development or revision to the responsible entity's Reliability Coordinator, adjacent Planning Coordinator(s), adjacent Transmission Planner(s), functional entities referenced in the Corrective Action Plan, and any functional entity that submits a written request and has a reliability-related need.

7.3.1.7.6.1. If a recipient of the Corrective Action Plan 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.

M7. Each responsible entity, as determined in Requirement R1, that concludes, through the GMD Vulnerability Assessment conducted in Requirement R4, that the responsible entity's System does not meet the performance requirements of Table 1 shall have evidence such as electronic or hard copies of its Corrective Action Plan, as specified in Requirement R7. Each responsible entity, as determined in Requirement R1, 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 Corrective Action Plan or relevant information, if any, within 90 calendar days of its completion to its Reliability Coordinator, adjacent Planning Coordinator(s), adjacent Transmission Planner(s), a functional entity referenced in the Corrective Action Plan, and any functional entity that submits a written request and has a reliability-related need, as specified in Requirement R7. Each responsible entity, as determined in Requirement R1, 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 Corrective Action Plan within 90 calendar days of receipt of those comments, in accordance with Requirement R7.

Table 1 –Steady State Planning Events				
<p>Steady State:</p> <ul style="list-style-type: none"> a. Voltage collapse, Cascading and uncontrolled islanding shall not occur. b. Generation loss is acceptable as a consequence of the planning 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	Load Loss Allowed
GMD GMD Event with Outages	1. System as may be postured in response to space weather information ¹ , and then 2. GMD event ²	Reactive Power compensation devices and other Transmission Facilities removed as a result of Protection System operation or Misoperation due to harmonics during the GMD event	Yes ³	Yes ³

Table 1 – Steady State Performance Footnotes
<ol style="list-style-type: none"> 1. The System condition for GMD planning may include adjustments to posture the System that are executable in response to space weather information. 2. The GMD conditions for the planning event are described in Attachment 1 (Benchmark GMD Event). 3. Load loss as a result of manual or automatic Load shedding (e.g. UVLS) and/or curtailment of Firm Transmission Service may be used to meet BES performance requirements during studied GMD conditions. The likelihood and magnitude of Load loss or curtailment of Firm Transmission Service should be minimized.

Attachment 1

Calculating Goelectric Fields for the Benchmark GMD Event

The benchmark GMD event¹ defines the goelectric field values used to compute GIC flows that are needed to conduct a GMD Vulnerability Assessment. It is composed of the following elements: (1) a reference peak goelectric field amplitude of 8 V/km derived from statistical analysis of historical magnetometer data; (2) scaling factors to account for local geomagnetic latitude; (3) scaling factors to account for local earth conductivity; and (4) a reference geomagnetic field time series or waveshape to facilitate time-domain analysis of GMD impact on equipment.

The regional goelectric field peak amplitude used in GMD Vulnerability Assessment, E_{peak} , can be obtained from the reference goelectric field value of 8 V/km using the following relationship

$$E_{\text{peak}} = 8 \times \alpha \times \beta \text{ (V/km)} \quad (1)$$

where α is the scaling factor to account for local geomagnetic latitude, and β is a scaling factor to account for the local earth conductivity structure.

Scaling the Geomagnetic Field

The benchmark GMD event is defined for geomagnetic latitude of 60° and it must be scaled to account for regional differences based on geomagnetic latitude. Table 2 provides a scaling factor correlating peak goelectric field to geomagnetic latitude. Alternatively, the scaling factor α is computed with the empirical expression

$$\alpha = 0.001 \cdot e^{(0.115L)} \quad (2)$$

where L is the geomagnetic latitude in degrees and $0.1 \leq \alpha \leq 1$

For large planning areas that cover more than one scaling factor from Table 2, the GMD Vulnerability Assessment should be based on a peak goelectric field that is:

- calculated by using the most conservative (largest) value for α ; or
- calculated assuming a non-uniform or piecewise uniform geomagnetic field.

¹ The benchmark GMD event description is available on the Project 2013-03 Geomagnetic Disturbance Mitigation project page: <http://www.nerc.com/pa/Stand/Pages/Project-2013-03-Geomagnetic-Disturbance-Mitigation.aspx>

Geomagnetic Latitude (Degrees)	Scaling Factor ¹ (α)
≤ 40	0.10
45	0.2
50	0.3
54	0.5
56	0.6
57	0.7
58	0.8
59	0.9
≥ 60	1.0

Scaling the Geoelectric Field

The benchmark GMD event is defined for the reference Quebec earth model described in Table 4. The peak geoelectric field, E_{peak} , used in a GMD Vulnerability Assessment may be obtained by either

- Calculating the geoelectric field for the ground conductivity in the planning area and the reference geomagnetic field time series scaled according to geomagnetic latitude, using a procedure such as the plane wave method described in the NERC GMD Task Force GIC Application Guide;² or
- Using the earth conductivity scaling factor β from Table 3 that correlates to the ground conductivity map in Figure 1 or Figure 2. Along with the scaling factor α from equation (2) or Table 2, β is applied to the reference geoelectric field using equation (1) to obtain the regional geoelectric field peak amplitude E_{peak} to be used in GMD Vulnerability Assessment. When a ground conductivity model is not available, the planning entity should use the largest β factor of adjacent physiographic regions or a technically justified value.

The earth models used to calculate Table 3 for the United States were obtained from publicly available information published on the U. S. Geological Survey website.³ The models used to calculate Table 3 for Canada were obtained from Natural Resources Canada (NRCan) and reflect the average structure for large regions. A planner can also use specific earth model(s) with documented justification and the reference geomagnetic field time series to calculate the β factor(s) as follows:

$$\beta = E/\delta \tag{3}$$

² Available at the NERC GMD Task Force project page: [http://www.nerc.com/comm/PC/Pages/Geomagnetic-Disturbance-Task-Force-\(GMDTF\)-2013.aspx](http://www.nerc.com/comm/PC/Pages/Geomagnetic-Disturbance-Task-Force-(GMDTF)-2013.aspx)

³ Available at <http://geomag.usgs.gov/conductivity/>

where E is the absolute value of peak geoelectric in V/km obtained from the technically justified earth model and the reference geomagnetic field time series.

For large planning areas that span more than one β scaling factor, the most conservative (largest) value for β may be used in determining the peak geoelectric field to obtain conservative results. Alternatively, a planner could perform analysis using a non-uniform or piecewise uniform geoelectric field.

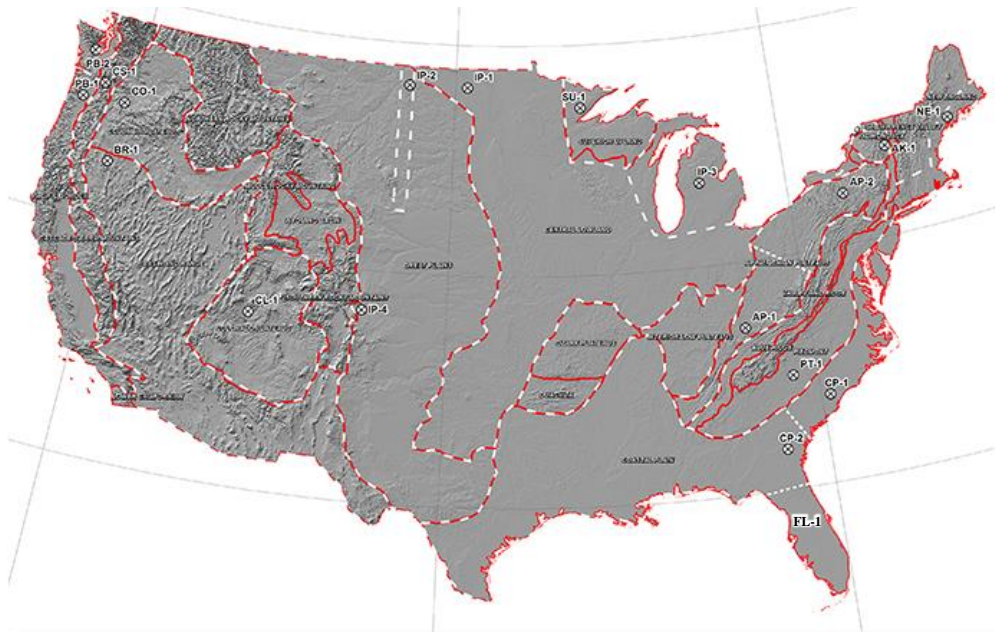


Figure 1: Physiographic Regions of the Continental United States⁴



Figure 2: Physiographic Regions of Canada

⁴ Additional map detail is available at the U.S. Geological Survey (<http://geomag.usgs.gov/>)

Table 3 – Geoelectric Field Scaling Factors	
USGS Earth model	Scaling Factor (β)
AK1A	0.56
AK1B	0.56
AP1	0.33
AP2	0.82
BR1	0.22
CL1	0.76
CO1	0.27
CP1	0.81
CP2	0.95
FL1	0.74
CS1	0.41
IP1	0.94
IP2	0.28
IP3	0.93
IP4	0.41
NE1	0.81
PB1	0.62
PB2	0.46
PT1	1.17
SL1	0.53
SU1	0.93
BOU	0.28
FBK	0.56
PRU	0.21
BC	0.67
PRAIRIES	0.96
SHIELD	1.0
ATLANTIC	0.79

Table 4 – Reference Earth Model (Quebec)	
Layer Thickness (km)	Resistivity (Ω -m)
15	20,000
10	200
125	1,000
200	100
∞	3

Reference Geomagnetic Field Time Series or Waveshape⁵

The geomagnetic field measurement record of the March 13-14 1989 GMD event, measured at NRCan’s Ottawa geomagnetic observatory is the basis for the reference geomagnetic field waveshape to be used to calculate the GIC time series, $GIC(t)$, required for transformer thermal impact assessment.

The geomagnetic latitude of the Ottawa geomagnetic observatory is 55° ; therefore, the amplitude of the geomagnetic field measurement data were scaled up to the 60° reference geomagnetic latitude (see Figure 3) such that the resulting peak geoelectric field amplitude computed using the reference earth model was 8 V/km (see Figures 4 and 5). Sampling rate for the geomagnetic field waveshape is 10 seconds.⁶ To use this geoelectric field time series when a different earth model is applicable, it should be scaled with the appropriate conductivity scaling factor β .

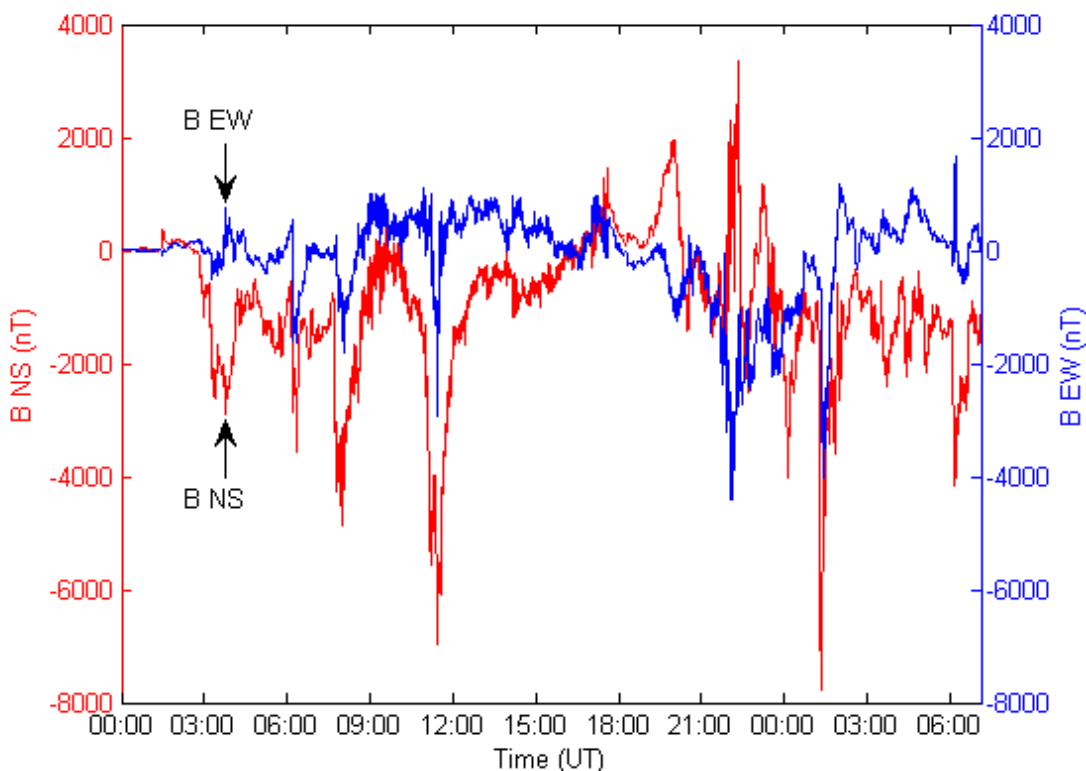


Figure 3: Benchmark Geomagnetic Field Waveshape. Red B_n (Northward), Blue B_e (Eastward)

⁵ Refer to the Benchmark GMD Event Description for details on the determination of the reference geomagnetic field waveshape: <http://www.nerc.com/pa/Stand/Pages/Project-2013-03-Geomagnetic-Disturbance-Mitigation.aspx>

⁶ The data file of the benchmark geomagnetic field waveshape is available on the NERC GMD Task Force project page: [http://www.nerc.com/comm/PC/Pages/Geomagnetic-Disturbance-Task-Force-\(GMDTF\)-2013.aspx](http://www.nerc.com/comm/PC/Pages/Geomagnetic-Disturbance-Task-Force-(GMDTF)-2013.aspx)

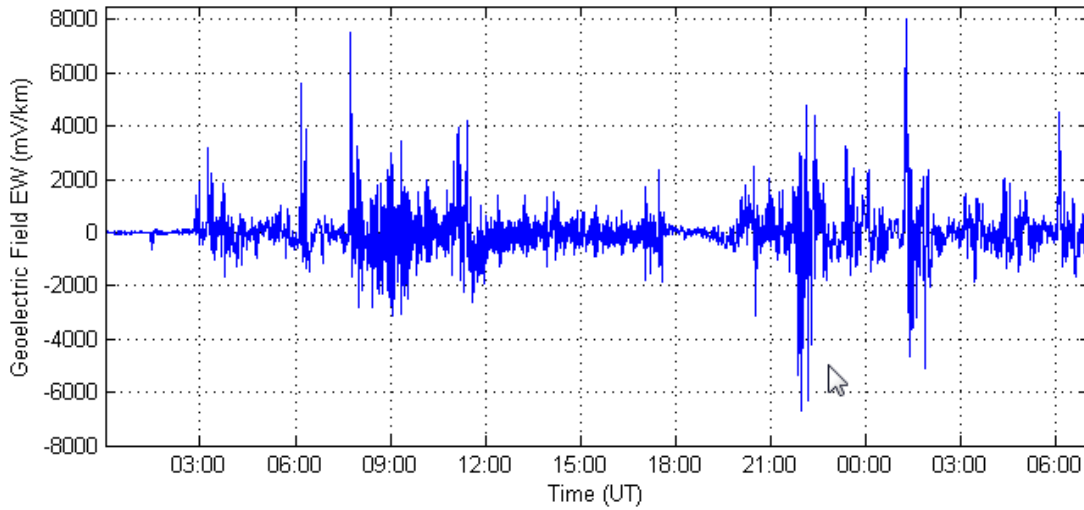


Figure 4: Benchmark Geoelectric Field Waveshape - E_E (Eastward)

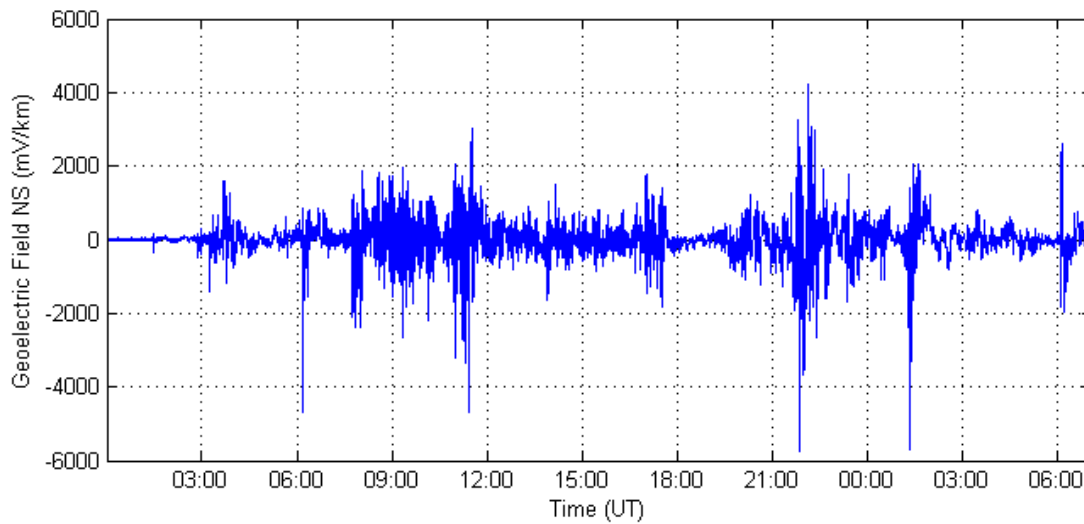


Figure 5: Benchmark Geoelectric Field Waveshape - E_N (Northward)

C. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority

As defined in the NERC Rules of Procedure, “Compliance Enforcement Authority” means NERC or the Regional Entity in their respective roles of monitoring and enforcing compliance with the NERC Reliability Standards

1.2. Evidence Retention

The following evidence retention periods identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the CEA may ask an entity to provide other evidence to show that it was compliant for the full time period since the last audit.

The Planning Coordinator, Transmission Planner, Transmission Owner, and Generator Owner shall keep data or evidence to show compliance as identified below unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation:

For Requirements R1, R2, R3, R5, and R6, each responsible entity shall retain documentation as evidence for five years.

For Requirement R4, each responsible entity shall retain documentation of the current GMD Vulnerability Assessment and the preceding GMD Vulnerability Assessment.

For Requirement R7, each responsible entity shall retain documentation as evidence for five years or until all actions in the Corrective Action Plan are completed, whichever is later.

If a Planning Coordinator, Transmission Planner, Transmission Owner, or Generator Owner is found non-compliant it shall keep information related to the non-compliance until mitigation is complete and approved or for the time specified above, whichever is longer.

The Compliance Enforcement Authority shall keep the last audit records and all requested and submitted subsequent audit records.

1.3. Compliance Monitoring and Assessment Processes:

- Compliance Audits
- Self-Certifications
- Spot Checking
- Compliance Investigations
- Self-Reporting
- Complaints

1.4. Additional Compliance Information

None

Table of Compliance Elements

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
R1	Long-term Planning	Lower	N/A	N/A	N/A	The Planning Coordinator, in conjunction with its Transmission Planner(s), failed to determine and identify individual or 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).
R2	Long-term Planning	High	N/A	N/A	The responsible entity did not maintain either System models or GIC System models of the responsible	The responsible entity did not maintain both System models and GIC System models of the responsible

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					entity’s planning area for performing the study or studies needed to complete GMD Vulnerability Assessment(s).	entity’s planning area for performing the study or studies needed to complete GMD Vulnerability Assessment(s).
R3	Long-term Planning	Medium	N/A	N/A	N/A	The responsible entity did not have criteria for acceptable System steady state voltage performance for its System during the benchmark GMD event described in Attachment 1 as required.
R4	Long-term Planning	High	The responsible entity completed a GMD Vulnerability Assessment, but it was more than 60 calendar months and less than or equal to 64 calendar months since the last GMD Vulnerability Assessment.	The responsible entity's completed GMD Vulnerability Assessment failed to satisfy one of elements listed in Requirement R4, Parts 4.1 through 4.3; OR The responsible entity completed a GMD Vulnerability Assessment, but it	The responsible entity's completed GMD Vulnerability Assessment failed to satisfy two of the elements listed in Requirement R4, Parts 4.1 through 4.3; OR The responsible entity completed a GMD Vulnerability Assessment, but it	The responsible entity's completed GMD Vulnerability Assessment failed to satisfy three of the elements listed in Requirement R4, Parts 4.1 through 4.3; OR The responsible entity completed a GMD Vulnerability Assessment, but it

				was more than 64 calendar months and less than or equal to 68 calendar months since the last GMD Vulnerability Assessment.	was more than 68 calendar months and less than or equal to 72 calendar months since the last GMD Vulnerability Assessment.	was more than 72 calendar months since the last GMD Vulnerability Assessment; OR The responsible entity does not have a completed GMD Vulnerability Assessment.
R5	Long-term Planning	Medium	The responsible entity provided the effective GIC time series, GIC(t), in response to written request, but did so more than 90 calendar days and less than or equal to 100 calendar days after receipt of a written request.	The responsible entity provided the effective GIC time series, GIC(t), in response to written request, but did so more than 100 calendar days and less than or equal to 110 calendar days after receipt of a written request.	The responsible entity provided the effective GIC time series, GIC(t), in response to written request, but did so more than 110 calendar days after receipt of a written request.	The responsible entity did not provide the maximum effective GIC value to the Transmission Owner and Generator Owner that owns each applicable BES power transformer in the planning area; OR The responsible entity did not provide the effective GIC time series, GIC(t), upon written request.

<p>R6</p>	<p>Long-term Planning</p>	<p>Medium</p>	<p>The responsible entity failed to conduct a thermal impact assessment for 5% or less or one of its solely owned and jointly owned applicable BES power transformers (whichever is greater) where the maximum effective GIC value provided in Requirement R5, Part 5.1, is 75 A or greater per phase; OR The responsible entity conducted a thermal impact assessment for its solely owned and jointly owned applicable BES power transformers where the maximum effective GIC value provided in Requirement R5, Part 5.1, is 75 A or greater per phase but did so more than 24 calendar months and less than</p>	<p>The responsible entity failed to conduct a thermal impact assessment for more than 5% up to (and including) 10% or two of its solely owned and jointly owned applicable BES power transformers (whichever is greater) where the maximum effective GIC value provided in Requirement R5, Part 5.1, is 75 A or greater per phase; OR The responsible entity conducted a thermal impact assessment for its solely owned and jointly owned applicable BES power transformers where the maximum effective GIC value provided in Requirement R5, Part 5.1, is 75 A or greater per phase but did so</p>	<p>The responsible entity failed to conduct a thermal impact assessment for more than 10% up to (and including) 15% or three of its solely owned and jointly owned applicable BES power transformers (whichever is greater) where the maximum effective GIC value provided in Requirement R5, Part 5.1, is 75 A or greater per phase; OR The responsible entity conducted a thermal impact assessment for its solely owned and jointly owned applicable BES power transformers where the maximum effective GIC value provided in Requirement R5, Part 5.1, is 75 A or greater per phase but did so</p>	<p>The responsible entity failed to conduct a thermal impact assessment for more than 15% or more than three of its solely owned and jointly owned applicable BES power transformers (whichever is greater) where the maximum effective GIC value provided in Requirement R5, Part 5.1, is 75 A or greater per phase; OR The responsible entity conducted a thermal impact assessment for its solely owned and jointly owned applicable BES power transformers where the maximum effective GIC value provided in Requirement R5, Part 5.1, is 75 A or greater per phase but did so more than 30 calendar</p>
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			<p>or equal to 26 calendar months of receiving GIC flow information specified in Requirement R5, Part 5.1.</p>	<p>more than 26 calendar months and less than or equal to 28 calendar months of receiving GIC flow information specified in Requirement R5, Part 5.1; OR The responsible entity failed to include one of the required elements as listed in Requirement R6, Parts 6.1 through 6.3.</p>	<p>more than 28 calendar months and less than or equal to 30 calendar months of receiving GIC flow information specified in Requirement R5, Part 5.1; OR The responsible entity failed to include two of the required elements as listed in Requirement R6, Parts 6.1 through 6.3.</p>	<p>months of receiving GIC flow information specified in Requirement R5, Part 5.1; OR The responsible entity failed to include three of the required elements as listed in Requirement R6, Parts 6.1 through 6.3.</p>
R7	Long-term Planning	High	N/A	<p>The responsible entity's Corrective Action Plan failed to comply with one of the elements in Requirement R7, Parts 7.1 through 7.3.</p>	<p>The responsible entity's Corrective Action Plan failed to comply with two of the elements in Requirement R7, Parts 7.1 through 7.3.</p>	<p>The responsible entity's Corrective Action Plan failed to comply with all three of the elements in Requirement R7, Parts 7.1 through 7.3; OR The responsible entity did not have a Corrective Action Plan as required by Requirement R7.</p>

D. Regional Variances

None.

E. Interpretations

None.

F. Associated Documents

None.

Version History

Version	Date	Action	Change Tracking
1	December 17, 2014	Adopted by the NERC Board of Trustees	

Application Guidelines

Guidelines and Technical Basis

Benchmark GMD Event (Attachment 1)

The benchmark GMD event defines the geoelectric field values used to compute GIC flows that are needed to conduct a GMD Vulnerability Assessment. A white paper that includes the event description, analysis, and example calculations is available on the Project 2013-03 Geomagnetic Disturbance Mitigation project page:

<http://www.nerc.com/pa/Stand/Pages/Project-2013-03-Geomagnetic-Disturbance-Mitigation.aspx>

Requirement R2

A GMD Vulnerability Assessment requires a GIC System model, which is a dc representation of the System, to calculate GIC flow. In a GMD Vulnerability Assessment, GIC simulations are used to determine transformer Reactive Power absorption and transformer thermal response.

Details for developing the GIC System model are provided in the NERC GMD Task Force guide: *Application Guide for Computing Geomagnetically-Induced Current in the Bulk Power System*.

The guide is available at:

http://www.nerc.com/comm/PC/Geomagnetic%20Disturbance%20Task%20Force%20GMDTF%20202013/GIC%20Application%20Guide%202013_approved.pdf

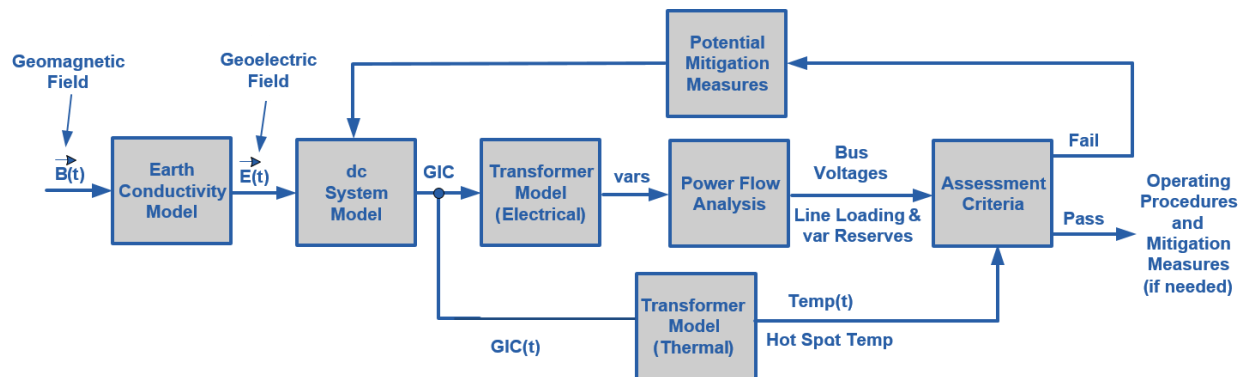
Underground pipe-type cables present a special modeling situation in that the steel pipe that encloses the power conductors significantly reduces the geoelectric field induced into the conductors themselves, while they remain a path for GIC. Solid dielectric cables that are not enclosed by a steel pipe will not experience a reduction in the induced geoelectric field. A planning entity should account for special modeling situations in the GIC system model, if applicable.

Requirement R4

The *GMD Planning Guide* developed by the NERC GMD Task Force provides technical information on GMD-specific considerations for planning studies. It is available at:

http://www.nerc.com/comm/PC/Geomagnetic%20Disturbance%20Task%20Force%20GMDTF%20202013/GMD%20Planning%20Guide_approved.pdf

The diagram below provides an overall view of the GMD Vulnerability Assessment process:



Application Guidelines

Requirement R5

The transformer thermal impact assessment specified in Requirement R6 is based on GIC information for the Benchmark GMD Event. This GIC information is determined by the planning entity through simulation of the GIC System model and must be provided to the entity responsible for conducting the thermal impact assessment. GIC information should be provided in accordance with Requirement R5 each time the GMD Vulnerability Assessment is performed since, by definition, the GMD Vulnerability Assessment includes a documented evaluation of susceptibility to localized equipment damage due to GMD.

The maximum effective GIC value provided in Part 5.1 is used for transformer thermal impact assessment. Only those transformers that experience an effective GIC value of 75 A or greater per phase require evaluation in Requirement R6.

GIC(t) provided in Part 5.2 is used to convert the steady-state GIC flows to time-series GIC data for transformer thermal impact assessment. This information may be needed by one or more of the methods for performing a thermal impact assessment. Additional information is in the following section and the thermal impact assessment white paper.

The peak GIC value of 75 Amps per phase has been shown through thermal modeling to be a conservative threshold below which the risk of exceeding known temperature limits established by technical organizations is low.

Requirement R6

The thermal impact assessment of a power transformer may be based on manufacturer-provided GIC capability curves, thermal response simulation, thermal impact screening, or other technically justified means. Approaches for conducting the assessment are presented in the *Transformer Thermal Impact Assessment* white paper posted on the project page.

<http://www.nerc.com/pa/Stand/Pages/Project-2013-03-Geomagnetic-Disturbance-Mitigation.aspx>

Transformers are exempt from the thermal impact assessment requirement if the effective GIC value for the transformer is less than 75 A per phase, as determined by a GIC analysis of the System. Justification for this criterion is provided in the *Screening Criterion for Transformer Thermal Impact Assessment* white paper posted on the project page. A documented design specification exceeding this value is also a justifiable threshold criterion that exempts a transformer from Requirement R6.

The threshold criteria and transformer thermal impact must be evaluated on the basis of effective GIC. Refer to the white papers for additional information.

Requirement R7

Technical considerations for GMD mitigation planning, including operating and equipment strategies, are available in Chapter 5 of the *GMD Planning Guide*. Additional information is available in the *2012 Special Reliability Assessment Interim Report: Effects of Geomagnetic Disturbances on the Bulk-Power System*:

<http://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/2012GMD.pdf>

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Rationale:

During development of this standard, text boxes were embedded within the standard to explain the rationale for various parts of the standard. Upon BOT approval, the text from the rationale text boxes was moved to this section.

Rationale for Applicability:

Instrumentation transformers and station service transformers do not have significant impact on geomagnetically-induced current (GIC) flows; therefore, these transformers are not included in the applicability for this standard.

Terminal voltage describes line-to-line voltage.

Rationale for R1:

In some areas, planning entities may determine that the most effective approach to conduct a GMD Vulnerability Assessment is through a regional planning organization. No requirement in the standard is intended to prohibit a collaborative approach where roles and responsibilities are determined by a planning organization made up of one or more Planning Coordinator(s).

Rationale for R2:

A GMD Vulnerability Assessment requires a GIC System model to calculate GIC flow which is used to determine transformer Reactive Power absorption and transformer thermal response. Guidance for developing the GIC System model is provided in the GIC Application Guide developed by the NERC GMD Task Force and available at:

http://www.nerc.com/comm/PC/Geomagnetic%20Disturbance%20Task%20Force%20GMDTF%202013/GIC%20Application%20Guide%202013_approved.pdf

The System model specified in Requirement R2 is used in conducting steady state power flow analysis that accounts for the Reactive Power absorption of power transformer(s) due to GIC in the System.

The GIC System model includes all power transformer(s) with a high side, wye-grounded winding with terminal voltage greater than 200 kV. The model is used to calculate GIC flow in the network.

The projected System condition for GMD planning may include adjustments to the System that are executable in response to space weather information. These adjustments could include, for example, recalling or postponing maintenance outages.

The Violation Risk Factor (VRF) for Requirement R2 is changed from Medium to High. This change is for consistency with the VRF for approved standard TPL-001-4 Requirement R1, which is proposed for revision in the NERC filing dated August 29, 2014 (RM12-1-000). NERC guidelines require consistency among Reliability Standards.

Rationale for R3:

Requirement R3 allows a responsible entity the flexibility to determine the System steady state voltage criteria for System steady state performance in Table 1. Steady state voltage limits are an example of System steady state performance criteria.

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Rationale for R4:

The GMD Vulnerability Assessment includes steady state power flow analysis and the supporting study or studies using the models specified in Requirement R2 that account for the effects of GIC. Performance criteria are specified in Table 1.

At least one System On-Peak Load and at least one System Off-Peak Load must be examined in the analysis.

Distribution of GMD Vulnerability Assessment results provides a means for sharing relevant information with other entities responsible for planning reliability. Results of GIC studies may affect neighboring systems and should be taken into account by planners.

The GMD Planning Guide developed by the NERC GMD Task Force provides technical information on GMD-specific considerations for planning studies. It is available at:

http://www.nerc.com/comm/PC/Geomagnetic%20Disturbance%20Task%20Force%20GMDTF%202013/GMD%20Planning%20Guide_approved.pdf

The provision of information in Requirement R4, Part 4.3, shall be subject to the legal and regulatory obligations for the disclosure of confidential and/or sensitive information.

Rationale for R5:

This GIC information is necessary for determining the thermal impact of GIC on transformers in the planning area and must be provided to entities responsible for performing the thermal impact assessment so that they can accurately perform the assessment. GIC information should be provided in accordance with Requirement R5 as part of the GMD Vulnerability Assessment process since, by definition, the GMD Vulnerability Assessment includes documented evaluation of susceptibility to localized equipment damage due to GMD.

The maximum effective GIC value provided in Part 5.1 is used for transformer thermal impact assessment.

GIC(t) provided in Part 5.2 can alternatively be used to convert the steady-state GIC flows to time-series GIC data for transformer thermal impact assessment. This information may be needed by one or more of the methods for performing a thermal impact assessment. Additional guidance is available in the Transformer Thermal Impact Assessment white paper:

<http://www.nerc.com/pa/Stand/Pages/Project-2013-03-Geomagnetic-Disturbance-Mitigation.aspx>

A Transmission Owner or Generator Owner that desires GIC(t) may request it from the planning entity. The planning entity shall provide GIC(t) upon request once GIC has been calculated, but no later than 90 calendar days after receipt of a request from the owner and after completion of Requirement R5, Part 5.1.

The provision of information in Requirement R5 shall be subject to the legal and regulatory obligations for the disclosure of confidential and/or sensitive information.

Rationale for R6:

The transformer thermal impact screening criterion has been revised from 15 A per phase to 75 A per phase. Only those transformers that experience an effective GIC value of 75 A per phase

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or greater require evaluation in Requirement R6. The justification is provided in the Thermal Screening Criterion white paper.

The thermal impact assessment may be based on manufacturer-provided GIC capability curves, thermal response simulation, thermal impact screening, or other technically justified means. The transformer thermal assessment will be repeated or reviewed using previous assessment results each time the planning entity performs a GMD Vulnerability Assessment and provides GIC information as specified in Requirement R5. Approaches for conducting the assessment are presented in the Transformer Thermal Impact Assessment white paper posted on the project page.

<http://www.nerc.com/pa/Stand/Pages/Project-2013-03-Geomagnetic-Disturbance-Mitigation.aspx>

Thermal impact assessments are provided to the planning entity, as determined in Requirement R1, so that identified issues can be included in the GMD Vulnerability Assessment (R4), and the Corrective Action Plan (R7) as necessary.

Thermal impact assessments of non-BES transformers are not required because those transformers do not have a wide-area effect on the reliability of the interconnected Transmission system.

The provision of information in Requirement R6, Part 6.4, shall be subject to the legal and regulatory obligations for the disclosure of confidential and/or sensitive information.

Rationale for R7:

Corrective Action Plans are defined in the NERC Glossary of Terms:

A list of actions and an associated timetable for implementation to remedy a specific problem.

Corrective Action Plans must, subject to the vulnerabilities identified in the assessments, contain strategies for protecting against the potential impact of the Benchmark GMD event, based on factors such as the age, condition, technical specifications, system configuration, or location of specific equipment. Chapter 5 of the NERC GMD Task Force *GMD Planning Guide* provides a list of mitigating measures that may be appropriate to address an identified performance issue.

The provision of information in Requirement R7, Part 7.3, shall be subject to the legal and regulatory obligations for the disclosure of confidential and/or sensitive information.

Rationale for Table 3:

Table 3 has been revised to use the same ground model designation, FL1, as is being used by USGS. The calculated scaling factor for FL1 is 0.74.