UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Reliability Standard for	)	
Transmission System Planned Performance	)	**Docket No. RM15-11-000**
for Geomagnetic Disturbance Events	)	

COMMENTS OF THE FOUNDATION FOR RESILIENT SOCIETIES
Submitted to FERC on October 22, 2015
Relating to U.S. Department of Energy-Released Los Alamos Report on
Proposed NERC Reliability Standard TPL-007-1

Introduction

Pursuant to the Federal Energy Regulatory Commission's ("FERC" or "Commission") Notice of Proposed Rulemaking ("GMD NOPR") issued on May 14, 2015,[1] the Foundation for Resilient Societies ("Resilient Societies") respectfully submits reply comments in regard to a report sponsored by the U.S. Department of Energy (DOE) and authored by the Los Alamos National Laboratory, "Review of the GMD Benchmark Event in TPL-007-1" (hereafter "LANL Report"). This LANL Report by Messrs. Rivera and Backhaus reviewed the NERC Benchmark GMD Event model in proposed Reliability Standard TPL-007-1 of the North American Electric Reliability Corporation (NERC). The LANL Report was publicly released by the U.S. Department of Energy on September 23, 2015, well after comment deadlines for FERC Docket No. RM15-11-000.[2]

The LANL Report found serious deficiencies in Reliability Standard TPL-007-1, including:

1. Statistical errors in the methodology of the Standard Drafting Team that resulted in an estimated geoelectric field for the Benchmark GMD Event of 5.77 volts/kilometer (adjusted upward in the Standard to 8 volts/kilometer as an implicit safety margin), as

[1] *Reliability Standard for Transmission System Planned Performance for Geomagnetic Disturbance Events*, Notice of Proposed Rulemaking (NOPR), 151 FERC ¶ 61,134 (May 14, 2015) ("GMD NOPR"), 80 FR 29990 (May 26, 2015).
[2] Michael Rivera and Scott Backhaus, *Review of the GMD Benchmark Event in TPL-007-1*, Los Alamos National Laboratory Report LA-UR-15-25609, September 14, 2015, released on DOE website Sep.23, 2015.

compared to a range of 8.4 volts/kilometer to 16.6 volts/kilometer using the alternative methodology of the LANL Report.

2. Statistical errors in the methodology of the Standard Drafting Team that resulted in geomagnetic latitude scaling factors too low by a factor of up to three (3) for mid-latitude locations such as New York City, as compared to the alternative methodology of the LANL Report.
3. Use of United States Geological Service (USGS) ground conductivity models by the Standard Drafting Team without consideration of uncertainties in the models, resulting in estimated geoelectric fields in the Benchmark GMD Event that do not use "worst-case" scenarios.

Background

The history of FERC Rulemaking Docket No. RM15-11-000 has been one of comment periods set by the Commission with knowledge that relevant information and documents would not be publicly available within the comment periods, *ex parte* meetings between technical experts and the Commission regarding information and documents not disclosed on the public docket, and relevant technical evaluations of the Benchmark GMD Event produced at taxpayer expense but withheld from the public docket until public outcry or private action resulted in the documents being made available for comment. The combined effect of these actions or inactions by the Commission has been to cause unequal access to relevant information among interested parties, unequal time to formulate comments for the docket, and unequal access and influence with FERC Commissioners and Staff. These arbitrary and capricious actions by the Commission have caused harm to the public interest that can only partially be remedied by extension of comment periods. Nonetheless, Resilient Societies appreciates this opportunity for a 20-day reply comment period.

When FERC issued the GMD NOPR on May 14, 2015, the Commission was fully aware that Resilient Societies had filed a Level 2 Appeal of NERC Reliability Standard TPL-007-001, because on May 12, 2015, Resilient Societies had filed a request for the Commission to stay issuance of a

NOPR on Reliability Standard TPL-007-1 until the results of the Level 2 Appeal were publicly available. This request by Resilient Societies was denied by the Commission. While the schedule for Rulemaking RM15-11-000 could have been easily delayed until the complete record of standard-setting for Standard TPL-007-1 was available, including the results and transcript of the Level 2 Appeal of Resilient Societies and other parties, the Commission nonetheless decided to issue the NOPR before the long-delayed Level 2 Appeal was even scheduled by NERC. In fact, NERC notified appellants of the date for Level 2 Appeal on May 16, 2015, only two days after the May 14, 2015 release of the GMD NOPR. While the Commission did ultimately grant a comment period on the result of the Level 2 Appeal, the result was unequal, because NERC and its industry participants had insider information on the probable result of the appeal long before other disadvantaged public participants.

Unknown to disadvantaged public participants, FERC Staff conducted *ex parte* meetings and collected technical documents relevant to Docket RM15-11-000. For example, Professor Adam Schultz of the University of Oregon reportedly gave a briefing to FERC Staff on March 18, 2015 regarding deficiencies in the USGS ground models used by the NERC Standard Drafting Team, but these briefing slides were not placed in the docket; instead, the slides became public through the independent disclosure of Professor Schultz. As another example, FERC Staff reportedly met (at an undisclosed date) with researchers from Los Alamos National Laboratory to discuss their independent review of the methodology of the NERC Standard Drafting Team in developing the Benchmark GMD Event in Standard TPL-007-1; the LANL Report was made public only after a protest to FERC Chairman Norman Bay by Senators Markey and Booker.

Now FERC has granted a 20-day comment period on the results of the LANL Report. Resilient Societies and other public participants must comment on a complex technical document long after FERC Staff and Commissioners have had access to the information and well into the consideration period for the GMD NOPR.[3]

[3] Because FERC Commissioners and Staff have *ex parte* communications with NERC and/or industry participants on rulemakings, there is the additional possibility that key personnel at NERC and electric utilities had advance notice of the findings of the LANL Report and the briefing to FERC by Professor Schultz.

Relevant Findings of the LANL Report

Resilient Societies appreciates the work of Los Alamos National Laboratory in reviewing the statistical methodologies employed by the NERC Standard Drafting Team in the development of the Benchmark GMD Event for Standard TPL-007-1. Resilient Societies also appreciates the sponsorship of the U.S. Department of Energy for this work. Analysis of NERC standards by independent and credible technical experts has been too frequently missing from the rulemaking process—this latest effort by LANL is a welcome addition to public scrutiny of NERC and its standard-setting process.

Maximum Geoelectric Field of Standard TPL-007-1 Biased Downward

The NERC Standard Drafting Team computed spatially averaged geoelectric field amplitude statistics to indicate that the 1-in-100 year geoelectric field amplitude would be approximately between 3 V/kilometer and 8 V/kilometer. The Standard Drafting Team used extreme value analysis to hypothesize that the upper limit of geoelectric fields (at the 95% confidence interval) would be 5.77 V/kilometer. The Standard Drafting Team then added an implicit safety factor of 1.4 to arrive at the maximum geoelectric field of 8 V/kilometer used in Standard TPL-007-1.

The authors of the LANL Report found the NERC Standard Drafting Team erred in assuming that samples of the geoelectric field magnitude are independent within a small time scale such as two minutes. The authors concluded:

> The over-counting of samples injects a bias into geo-electric field magnitude statistics by adding more counts at geo-electric field magnitudes below the independent peak magnitudes, resulting in an artificially faster decline of the event rates. This bias results in an underestimation of the rate of high-magnitude geo-electric field events…
>
> We find a one-in-one-hundred year geo-electric field magnitude for a statistically independent GMD event with an average of 13.2 V/km, a median of 13.5 V/km and a range of 8.4 V/km to 16.6 V/km.

Absent any implicit safety factor in the NERC standard, the LANL Report concluded that the maximum geoelectric field used to develop Standard TPL-007-1 was biased downward by an approximate factor of nearly three (3)—an upper limit of 5.77 V/kilometer as estimated for the

NERC Benchmark GMD Event vs. an upper limit of 16.6 V/kilometer as estimated in the LANL Report.

Latitude Scaling Factors of Standard TPL-007-1 Biased Downward

The NERC Standard Drafting Team developed geomagnetic latitude scaling factors to adjust downward their maximum geoelectric field for a 1-in-100 year event. The scaling factors were purportedly obtained from empirical observations of a large number of global geomagnetic field observations of all major geomagnetic storms since the late 1980s. The NERC scaling factors significantly reduce the maximum geoelectric field that utilities must protect against—for example, the scaling factor for grid facilities in the vicinity of the major population center of New York City would be an approximate factor of 0.4 downward. The table of NERC scaling factors is displayed below; all of these factors are one or less.

Table 2– Geomagnetic Field Scaling Factors	
Geomagnetic Latitude (Degrees)	Scaling Factor1 (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

Figure 1. Table of Geoelectric Field Scaling Factors for Geomagnetic Latitude in Standard TPL-007-1

The authors of the LANL Report found dB/dt from large solar storms have significant and systematic deviations from the proposed NERC scaling law:

> From this analysis, it is clear that the NERC-proposed scaling, which was empirically derived from statistics dominated by weaker disturbances, does not accurately represent the stronger events at lower Dst. We speculate that for the disturbances with Dst < –300, the Earth's auroral electrojet is moving to lower magnetic latitude, and the appearance and growth of the peak in dB/dt as Dst becomes more negative as a result of this movement. Whether this speculation is correct or not, the results in Figure 4 indicate that ***the scaling of the geo-electric field in TPL-007-1 does not capture the behavior of large disturbances during periods of very low Dst.***

The LANL Report contains a ratio of the authors' computed geomagnetic latitude scaling factors with the NERC factors, as shown in their Figure 5 and accompanying explanation:

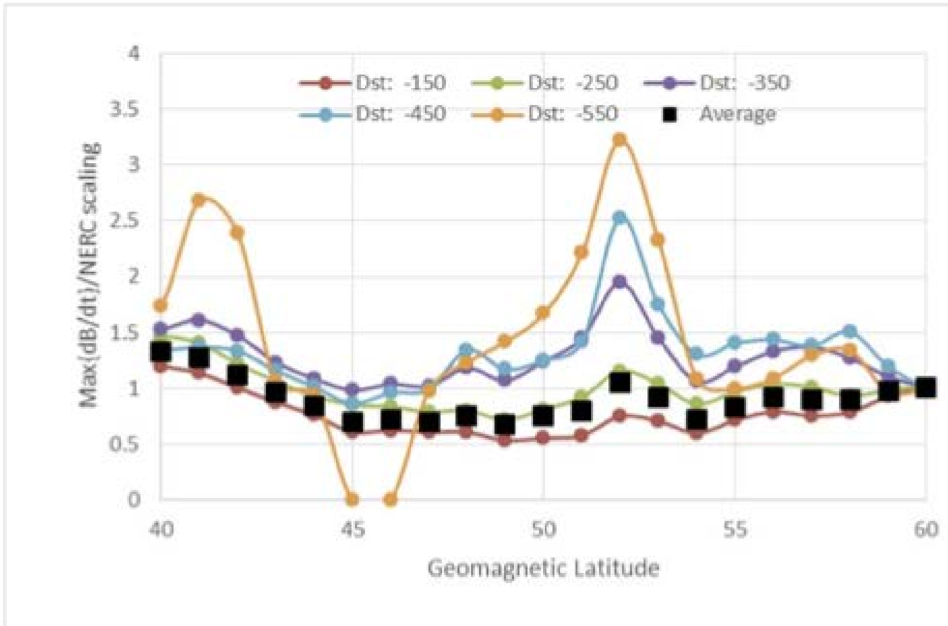

Figure 5. Average maximum |dB/dt| for the largest 122 geomagnetic disturbances from 1980 through 2011, conditioned on the strength of the disturbance (*Dst*) and normalized by the suggested NERC scaling. The *Dst*=–550 and –450 bins each contain one disturbance. The *Dst*=–350, –250, and –150 bins contain 7, 19, and 94 disturbances, respectively. The black dots represent an average over all *Dst* values. A value of 1.0 corresponds to a perfect agreement with NERC scaling predictions.

Figure 2. Illustration of Discrepancies between Observed Data and NERC Scaling Predictions Taken from Figure 5 of Los Alamos National Laboratory Report on Standard TPL-007-1

As shown in the above figure, NERC scaling predictions are off by a factor of 2.5 to 3.2 for the two largest solar storms at approximately 52 degrees geomagnetic latitude.

Due to these obvious discrepancies between the NERC geoelectric field scaling factors for geomagnetic latitude and observed data, the authors of the LANL Report suggested a factor of two as a "conservative correction factor":

> The physics and location of the electrojet during large GMD introduces a significant uncertainty into the latitude scaling suggested in TPL-007-1. Data-driven models based on historical observations will not capture the behavior of events like the TPL-007-1 Benchmark Event because there are currently no observations of events this large. Instead, a physically motivated model of the electrojet is needed to effectively extrapolate the small to moderate disturbance data currently in the historical record to disturbances as large as the TPL-007-1 Benchmark Event. Until the time that such a model is developed, an additional degree of conservatism in the mid-geomagnetic latitudes is warranted.

> Figure 5 gives an estimate of the correction factor. Discarding the strongest Dst bins, for which there are not more than a few, or even one, event in the average, ***we suggest a factor of two as a conservative correction factor.***
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> (Emphasis added.)

We comment that throwing out extreme observations, even those with a limited sample size, may be “conservative” in terms of not enforcing too-rigorous standards upon the electric utility industry, but this discard of extreme observations is certainly not the most ***prudent*** practice for the public interest. For remand to NERC, the Commission should ask for a prudent correction factor of at least three (3) instead of two (2) for geomagnetic latitude scaling.

Ground Models in Standard TPL-007-1 Do Not Consider “Worst Case”

NERC Standard TPL-007-1 allows utilities to use another yet another series of geoelectric field scaling factors (in addition to geomagnetic latitude scaling factors) to downwardly adjust for local ground conductivity. The ground model scaling factors are based on data from the USGS. Notably, of the 28 ground models and associated scaling factors, all but two downwardly adjust the maximum geoelectric field:

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

Figure 3. Table of Geoelectric Field Scaling Factors for USGS Earth Models in TPL-007-1

The authors of the LANL report found a "wide range of uncertainty within the USGS data for some of the reported values of ground conductivity" and concluded that "without specific data for the local Earth conductivity, TPL-007-1 should consider a worst-case scenario for each of the USGS regions." Furthermore, the LANL authors found:

> For several regions, the difference between the results for the recommended conductivity values and the maximum and minimum values is quite small (e.g., AK-1A), whereas other regions show substantial spread between the results (FL-1). The results obtained by using the recommended values of conductivity tend to the conservative end of the range

> between worst and best case, although for some regions (e.g., FL-1), the gap in peak geo-electric field between the recommended and worst case conductivity is considerable.
>
> Lacking better data for Earth conductivity, it seems prudent, within the scope of the one-dimensional plane wave model, to use the regionally specific, worst-case Earth conductivity configurations in the TPL-007-1 risk screening process.

Notably, the authors of the LANL Report analyzed "worst case" and "best case" ground conductivity models for only 8 of the 28 ground models in the Standard TPL-007-1. For Florida (Region FL-1) the difference between the "recommended conductivity value" used in the Standard TPL-007-1 and the "worst case" value was approximately 25%.

Multiplicative Effect of Systemic Biases in Standard TPL-007-1

For three critical aspects of Standard TPL-007-1—maximum geoelectric field, geomagnetic latitude scaling factors, and ground conductivity model scaling factors—there were systemic NERC biases all in the same non-prudent direction. According to the authors of the LANL Report, the biases were:

Maximum geoelectric field:	Negative factor of 3 (5.77 V/km vs. 16.6 V/km)
Geomagnetic latitude scaling:	Negative "correction factor of 2"
Ground conductivity scaling:	Negative factor of up to 25% (factor of 1.25)
Total multiplicative bias:	Negative factor of 6.0 to 7.5

The LANL Report did not recommend any overall "safety factor," although a safety factor of at least two is common in engineered structures. Application of a safety factor of two combined with other biases identified by LANL would yield the result of Standard TPL-007-1 being imprudently biased by a factor of at least 12 to 15. Further application of a prudent "correction factor" for geomagnetic latitude scaling of three instead of two, per our above comment, would yield Standard TPL-007-1 being imprudently biased by a factor of 18.0 to 22.5.

Potential Bias in LANL Report

We must note that in the responses to reviewers of the LANL Report, the authors show potential bias in addressing uncertainties inherent in limited data by writing:

> Backhaus/Rivera: We agree that the computed geo-electric field is more sensitive to uncertainty in the lower layers. However, the USGS data available to us report resistivity ranges only for the upper layers and not for the lower layers. The intent of this report is to discover and advise on the unresolved uncertainties within the TPL-007-1 screening process. ***If these uncertainties are overestimated without justification, the end result may be over-application of very expensive GMD mitigation measures on a nationwide basis.*** Therefore, we have chosen our current approach to avoid alarmism by only considering layers in the geological model where USGS provides ranges, even though those ranges are ill defined, with descriptive phrases like "possibly representative."
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> (Emphasis added.)

The authors of the LANL Report present no evidence whatsoever that over-application of GMD mitigation measures on a nationwide basis would be "very expensive." In fact, comprehensive application of GMD measures on a nationwide basis would cost just pennies per American per year, as we demonstrated in our prior comments in this docket.[4] One could more appropriately say that if uncertainties are ***underestimated without justification***, the end result may be ***under-application of cost-effective GMD mitigation measures,*** resulting in a long-term blackout. When a study conducted by the Oak Ridge National Laboratory and sponsored by FERC, DOE, and the Department of Homeland Security[5] concludes that a severe solar storm "could interrupt power to as many as 130 million people in the United States alone, requiring several years to recover," it is not "alarmist" to recommend prudent use of limited data.

[4] See in particular Appendix 1 of the August 10, 2015 filing by Resilient Societies in FERC Docket No. RM15-11-000. In Appendix 1 Capt. Jon Bate analyzes societal costs versus electric utility costs, and estimates net benefit-to-cost ratios of investing in protection of the Bulk Power System before a severe solar storm rather than incurring damages in the aftermath of a prolonged national or regional blackout. Neither NERC nor LANL has provided any quantitative economic analysis of cost-benefit ratios for various levels of proactive investments in solar storm protection.

[5] "Electromagnetic Pulse: Effects on the U.S. Power Grid," Oak Ridge National Laboratory, January 2010, available at http://www.ornl.gov/sci/ees/etsd/pes/pubs/ferc_Executive_Summary.pdf, last accessed October 22, 2015.

Issues Unaddressed in the LANL Report

The LANL Report took the approach of using the IMAGE magnetometer data from portions of northern Europe and Scandinavia at a 10 second resolution. This is essentially the same data used by the NERC Standard Drafting Team. Unfortunately, this approach excludes magnetometer data for major geomagnetic solar storms that occurred in August 1972, July 1982, and March 1989 that is available for observatories within the United States and Canada. While the United States and Canada magnetometer data is of lower resolution at 1 minute intervals, it covers a longer and more relevant time period. It is notable that neither the LANL Report authors nor its reviewers discussed the advantages and disadvantages of using data from larger storms at lower time resolution. Additionally, more primitive but still relevant data is available from extreme solar storms in 1921 and 1859. The arbitrary and unexplained exclusion of relevant data from large geomagnetic solar storms beyond the 20 years of European IMAGE data is a major defect of both the NERC Benchmark GMD Event and the LANL Report.

The LANL Report uses better and more rigorous statistical techniques and therefore its findings are more reliable than the NERC GMD Benchmark event. However, both the NERC Benchmark GMD Event and the LANL Report suffer from "unvalidated modeling" of predicted geoelectric fields, i.e., development of models without comparison to real world indications of geoelectric fields induced during solar storms, such as might be determined from measurements of Geomagnetically Induced Current (GIC) data for power transmission lines and telecommunications cables. Because the relationship between GIC and geoelectric fields is linear, real world measurements of GIC during small solar storms are indicative of geoelectric fields during large solar storms.[6] The exclusion of available real-world data is a shortfall in the application of the scientific method.

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[6] The relationship between the rate of change of magnetic field and geoelectric field is an application of Faraday's Law, which has a linear relationship between dB/dt and voltage. The relationship between geoelectric field and GIC is an application of Ohm's Law, which has a linear relationship between voltage (geoelectric field) and current (GIC). Therefore, measurement of GIC during small solar storms is linearly predictive of dB/dt and geoelectric field during severe solar storms.

Issues Considered in the IEEE Guide for Transformers under GMD

We note and concur with commentator David Jonas Bardin, a former attorney for the Federal Power Commission, in asking the Commission to officially recognize and include in Docket RM15-11-000 for rulemaking purposes the recently completed publication of the IEEE Transformers Committee entitled "IEEE Guide for Establishing Power Transformer Capability while under Geomagnetic Disturbances."[7] (Hereafter "IEEE Guide for Transformers under GMD").

The IEEE Guide for Transformers under GMD addresses factors that influence the degree of risk to power transformers, including:

- Geomagnetic latitude
- Local earth resistivity
- Coastal effect
- The network topology
- The design and technical specification of the power transformer
- Storm duration and intensity
- Loading.[8]

The IEEE Guide for Transformers under GMD does not quantify the "coastal effect" either generally or as a function of specific geoelectric regions of North America. In the event that the coastal effect is substantial, the NERC underestimation of GMD vulnerabilities could substantially exceed the 12X to 15X range resulting from the LANL review. We urge the Commission to require collection of GIC during past and future solar storms to determine the true magnitude of the coastal effect.

[7] Jane Ann Verner, et al., *IEEE Guide for Establishing Power Transformer Capability while under Geomagnetic Disturbances*, New York: IEEE Power and Energy Society, Sep. 3, 2015, released for sale on October 5, 2015. Printed or PDF versions of this Transformer Guide may be purchased at the IEEE website.
[8] Ibid, at 3-4.

Importantly, the IEEE Guide for Transformers under GMD in its assessment of thermal vulnerability (section 6) and evaluation of susceptibility of existing fleet of transformers to effects of GIC (section 8) recommends that most of the high voltage transformers be assessed for vulnerability and potential mitigation measures in the range of 15 Amps per phase to 75 amps per phase, and not just at 75 amps per phase or above.[9]

Were the Commission to require the reinstatement of a thermal assessment requirement for transformers initially assessed at risk of 15 amps per phase of modeled GIC or higher, this Standard would require assessment of transformers at Salem-1 and Salem-2 nuclear plants in New Jersey, site of previous transformer failures during solar storms.

The IEEE Guide for Transformers under GMD, which addresses key issues excluded from the LANL Report of September 2015, should by itself suffice to require remand of the NERC proposed Standard TPL-007-1, for a more prudential thermal assessment revision.

A related deficiency of the LANL Report is its failure to address vibrational hazards that impact power transformers and other critical grid equipment. The IEEE Guide for Transformers under GMD notes at Section 5.4:

> Other effects of GIC in transformers: Other effects of part-cycle core saturation are higher core sound levels, tank vibrations, and load sound levels during the GMD event. These high tank vibrations may cause loosening of terminal leads and may also impair accessories mounted on the tank.[10]

[9] Verner at al., ibid. at pp. 27-29 (2015).
[10] Verner, et al., ibid. at p. 8.

Benefits of a FERC Order for NERC or Regional Transmission Organizations to Expedite Regional Geoelectric Field Assessments

In Comments filed on October 20, 2015 in this Docket, attorney David Jonas Bardin has brought to the attention of the Commission a significant inequity in requirements for prospective electric grid reliability. Specifically, the Earthscope Project funded by the National Science Foundation (NSF) has no present plans to include regions of the United States that may have substantially above-average risks of electric outages due to severe GMD events.[11] Briefing materials of Dr. Jeffrey Love of the U.S. Geological Survey and others, submitted by attorney Bardin in this Docket, indicate that the New England states, the Mid-Atlantic States, and Gulf of Mexico-adjoining states are not presently scheduled for geoelectric field measurement and modeling under Earthscope funding.

Concurrently, 3-D magnetotelluric assessments by region can now be included in commercially available models of GMD that are available to utilities in well-modeled regions, but not available to utilities without the Earthscope modeling data.[12]

Resilient Societies urges the Commission to include in its GMD Rulemaking Order an obligation of either NERC or the Regional Transmission Organizations in regions without Earthscope assessment and modeling to sponsor, and to seek OATTS tariff cost recovery for 3-D geoelectric field assessment in each of the regions not presently within the scope of the NSF-sponsored Earthscope model. Without expedited 3-D modeling of geoelectric fields by specific sub-regions, electric customers in regions that lack 3-D modeling are less likely to receive the hardware protection of their regional electric grids vs. better protection for better modeled regions of the United States.

[11] The Lloyd's Report of June 2013, earlier included as a reference document in this Docket, identified the Mid-Atlantic states and New England as having higher electric equipment claims and higher GMD risks. In October 2015 Dr. William Murtagh, a lead coordinator of the federal government's Space Weather assessments and proposed Space Weather Action Plan of OSTP, et al. reaffirmed the particular vulnerability of these regions of the United States. See SWEF Conference presentations, Washington, D.C., October 20-21, 2015.

[12] PowerWorld, for example, offers linked modeling that can utilize 3-D geoelectric field data.

Neither the current NERC Benchmark GMD Event nor the LANL assessment of that model address important boundary conditions, including the effects of electric fields on transmission lines located in the transition from saline water bodies to higher resistivity land masses. Without a FERC-required initiative, including criteria for cost recovery of geoelectric field modeling, any modeling required by Standard TPL-007-1 may be unjust and unduly discriminatory, foreseeably placing at greater risk electricity customers who, through no fault of their own, live or work in regions of the United States without available 3-D geoelectric field modeling.[13]

Conclusion and Request for Remand

The review of NERC Standard TPL-007-1 by Los Alamos National Laboratory reveals systemic bias by the NERC Standard Drafting Team in development of the Benchmark GMD Event, including erroneous values for maximum geoelectric field, geomagnetic latitude scaling factors, and ground conductivity model scaling factors. These NERC biases are multiplicative, resulting in a reliability standard that indicates thresholds for hardware protective measures too low by a factor of 6.0 to 7.5. Application of a standard safety factor of two would make protective thresholds too low by a factor of 12 to 15. Further application of a prudent "correction factor" for geomagnetic latitude scaling would yield Standard TPL-007-1 being imprudently biased by a factor of 18 to 22. These multiplicative effects preclude a quick fix to Standard TPL-007-1 by simply changing one factor in isolation, such as the maximum geoelectric field, as is proposed by the Commission in the current GMD NOPR.

In order to aid in better geoelectric field estimates for electric utilities, FERC should require and expedite 3-D ground resistance modeling, with cost-recovery, for regions of the U.S. not now assessed or not within programmed plans for 3-D geoelectric field assessment.

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[13] Title 16 U.S.C. §824*o*(d)(2) requires that a rulemaking standard must be "not unduly discriminatory or preferential, and in the public interest."

The LANL Report is evidence, taken together with additional analyses, that the NERC Benchmark GMD Event and Standard TPL-007-1 should be remanded. Moreover, the recently published IEEE Guide for Transformers under GMD reaffirms and amplifies the need for a more prudential standard than the Commission proposed to adopt as Standard TPL-007-1. Without remand, the grossly inadequate NERC Standard will effectively discourage "best practices" that might have been implemented for reliable operation of the Bulk Power System had no standard been approved at all.

In its current form, Standard TPL-007-1 will provide liability protection to the electric utility industry from ongoing or prospective negligence in protecting from severe solar storms, but will not protect the public from long term outage and catastrophic loss of human life. Partial acceptance of Standard TPL-007-1 by the Commission would provide a false assurance to the public and eliminate utility incentives to install hardware protective equipment. This dangerously defective standard should be remanded in its entirety to NERC with instructions to collect and use real world data from major solar storms recorded in North America to develop the Benchmark GMD Event.

When technical documents relevant to the public interest of Standard TPL-007-1 are made available to FERC, this information should be placed on the public docket and an appropriate comment period should be established by order of the Commission.

Respectfully submitted by

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