June 8, 2015

Mr. Kenneth G. Peterson, Chair
Level 2 Appeal Panel
Board of Trustees
North American Electric Reliability Corporation
3353 Peachtree Road, N.E.
Atlanta, Georgia 30326

Dear Mr. Peterson:

Storm Analysis, LLC and Advanced Fusion Systems, LLC join in the Level 2 Appeal of the Foundation for Resilient Societies on reliability standard TPL-007-001, "Transmission System Planned Performance for Geomagnetic Disturbance Events." Our respective firms provide engineering consulting services and equipment to electric utilities needing to protect against geomagnetic disturbance (GMD).

An overview of the procedural errors leading to this inadequate standard is provided as an attachment to this letter. In short, NERC Standard TPL-007-001 was drafted in such a way that procedural errors will cause inadequate assessment of future storm threats to the electric power grid and as a result could lead to inadequate protection of the grid and the public for this threat. We have ethical requirements to notify NERC of the potential harm these inadequacies in the standard could cause to the public.

In addition, there are impacts of the standard that could harm our and other professional firms directly and materially from engaging in services in this topic area. We would be reluctant to provide services to electric utilities and electric power generators covered by this standard, especially knowing of the deficiencies.

Moreover, if our firms were to provide engineering services or equipment under TPL-007-001, there is potential for tremendous civil and criminal liability due to the defective nature of the standard. NERC's registered entities may gain a safe harbor from liability, but there would be no such protection for suppliers to the electric utility industry. This is another direct and material harm to our companies and all other companies that desire to provide such services and equipment.

As our appended summary describes, it is obvious that NERC did not perform even the most perfunctory quality control in the development of TPL-007-001. In particular, NERC did not collect available GIC data from electric utilities and utilize that data to check the quality of the standard. Moreover, NERC did not use transformer failure data available in its own TADS and GADS databases, the data bases of its member utility companies or a number of other publicly available data bases. These gaps in NERC data collection and use are well explained in the Level 1 Appeal of Resilient Societies. In addition, there are other significant scientific and engineering omissions and procedural errors noted in the appended report.

Other procedural defects in the development of TPL-007-001 are also explained in the Level 1 Appeal of Resilient Societies. we have read their appeal and agree with the points made.

In summary, it is clear that the processes for quality control as defined in the Standard Processes Manual were not followed for TPL-007-001.

The Level 2 Appeal Panel should require specific remedies of the Standard Drafting Team, including:

1. Replacement of downwardly averaged geoelectric fields, erroneously calculated per the hotspot conjecture, with maximum expected values.
2. Rework of the Benchmark GMD Event using available GIC data.
3. Rework of the Transformer Thermal Screening Criterion using transformer failure and observational data.
4. Examination of the impacts of vibration on transformers.
5. Examination of impacts of harmonics on grid equipment and utility customers.
6. Incorporation of safety factors.

Lastly, as an additional party to this Level 2 Appeal, we ask to be granted the same rights as the original party—namely, the right to make an oral presentation on June 29, 2015 to the panel.

Respectfully submitted by:

John Kappenman
Owner, Principal Consultant
Storm Analysis, LLC

Curtis Birnbach
President and Chief Technology Officer
Advanced Fusion Systems, LLC

Copies transmitted electronically on June 8, 2015 to: spmappeal@nerc.net

Appendix - An Overview Report on the NERC Standard TPL-007-001, Transmission System Planned Performance for Geomagnetic Disturbance Events

The purpose of this overview is to report on and document a number of the NERC procedural errors and quality control problems in the development of this standard. A brief description is provided for some of the most significant errors, omissions and quality control deficiencies in this standard. A discussion is also provided on the impacts that these quality control deficiencies have on engineering/scientific services firms and equipment manufacturers that would be engaged in supporting this inadequate standard.

Failure of the NERC Standards Drafting Team and NERC GMD Task Forces to Gather Relevant EHV Transformer Failure Data

NERC has failed to gather any relevant data on transformer failures that could be attributed to Geomagnetic Storms and GIC exposure in those transformers. Further there has been relevant information made available to NERC and the public and there was no efforts to incorporate the same within the consideration of NERC design standards. In 2014, Storm Analysis Consultants felt it was necessary to publicly file a report to the US FERC on this topic of GIC and GSU Transformer Failures due to the lack of attention and actions on the part of NERC on this important topic[1]. These GSU transformer failure events were reported in an IEEE Survey. There are also separate events of failures reported to the US Nuclear Regulatory Commission of transformer failures that happened within a 25 months after the March 1989 geomagnetic storm in addition to the Salem Nuclear Plant failure. Figure 1 provides a map of these nuclear plant transformer failure events.

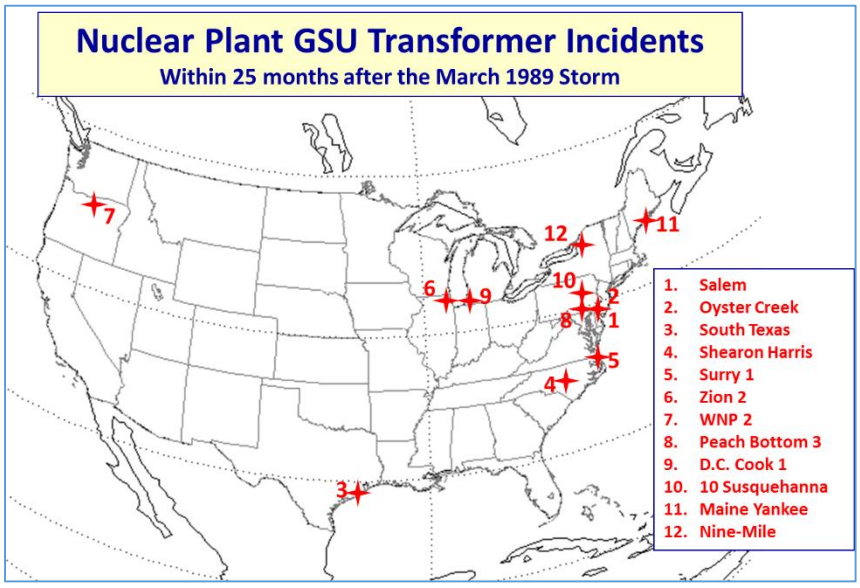


Figure 1-Map of Post March 1989 Geomagnetic Storm Nuclear Plant Transformer Events

An examination of these failure incidents also indicates that the failures are not just limited to thermal hot spots (which is the limited focus of the NERC Standard) but can also occur due to transformer vibration related sources due to the GIC-caused transformer saturation. These failure data bases are limited to GSU

[1] Storm Analysis Consultants, "REPORT ON ANALYSIS OF GEOMAGNETIC DISTURBANCES AND GENERATOR STEP UP TRANSFORMER FAILURES", Storm-R-133, September 30, 2013, US FERC Docket No. RM14-1-000.

transformers only, however, GIC will also expose and have the potential to cause similar failure incidents in the EHV autotransformers which make up a far larger percentage of the EHV transformer population. Hence even with these Non-NERC failure incident reports, a large unrecognized and important class of failure data has not been examined or considered for purposes of design of the NERC Draft Standard.

The NERC Standard Transformer Thermal Limits are Not Accurate

The standard includes GIC exposure and Transformer heating limits that have not been accurately assessed. The inputs for the NERC Standards appear to be derived from transformer manufacturer factory tests. However as pointed out by Kappenman and others, these tests were not correctly performed by the manufacturers as the tertiary winding of the autotransformers was not properly connected to simulate actual exposure. In comments that have been filed, it is shown that for autotransformers, the tertiary winding is the weakest point of the transformer and even small amounts of GIC exposure can lead to rapid and damaging overheating of this winding. Further there is actual geomagnetic storm GIC and transformer observational data which the NERC Standards Drafting team has overlooked that confirms this important vulnerability[2,3]. This important observational data has not been included in the NERC Draft standard and is an important engineering omission and procedural error in the standard. Figure 2 provides the NERC Draft Standard latest estimate of transformer thermal behavior due to GIC.

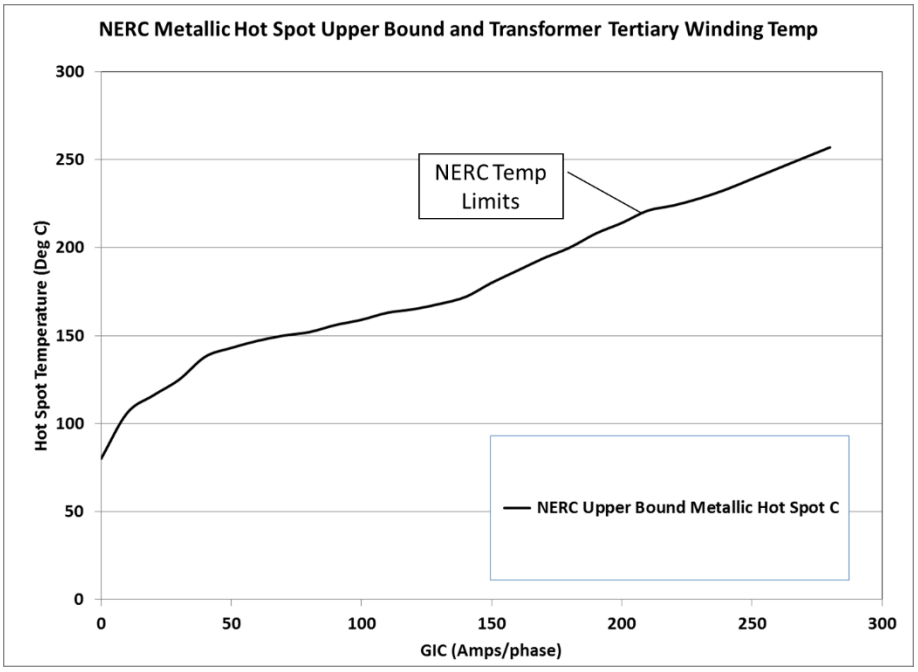


Figure 2 - Plot of NERC Table 1 Upper Bound of Peak Metallic Hot Spot Temps

This plot shows a semi-linear increase in temperature as a function of increasing GIC. Figure 3 superimposes the over looked tertiary winding limitations upon the NERC standard levels of Figure 2. As this reveals, the safe GIC levels decrease dramatically as temperatures in the tertiary windings can

[2] J. G. Kappenman, "An Overview of Geomagnetic Storm Impacts and the Role of Monitoring and Situational Awareness", IEEE Power Engineering Meeting Panel Presentation, July 2014.

[3] R.L. Lesher, J.W. Porter, R.T. Byerly, "SUNBURST-a network of GIC monitoring systems", IEEE Transactions on Power Delivery (Impact Factor: 1.66). 02/1994; DOI: 10.1109/61.277687

increase at exponential rates for low levels of GIC (levels of GIC at or below 100 Amps/phase in many large EHV autotransformers). This is a thermal runaway condition that can lead to rapid increases in winding temperature and permanent damage to critical assets on the EHV grid. These temperature increases are further straightforward calculations provided by existing transformer harmonic loading standards such as ANSI/IEEE C57.11-1986, hence the NERC Draft standard is flawed in overlooking and fully considering this relevant equipment standard. Rather than the 75 Amp per phase GIC threshold incorporated into the NERC Draft Standard, Figure 3 shows that onset of damage could occur at much lower levels of GIC in autotransformers, which constitute the majority of transformers connected to the EHV network.

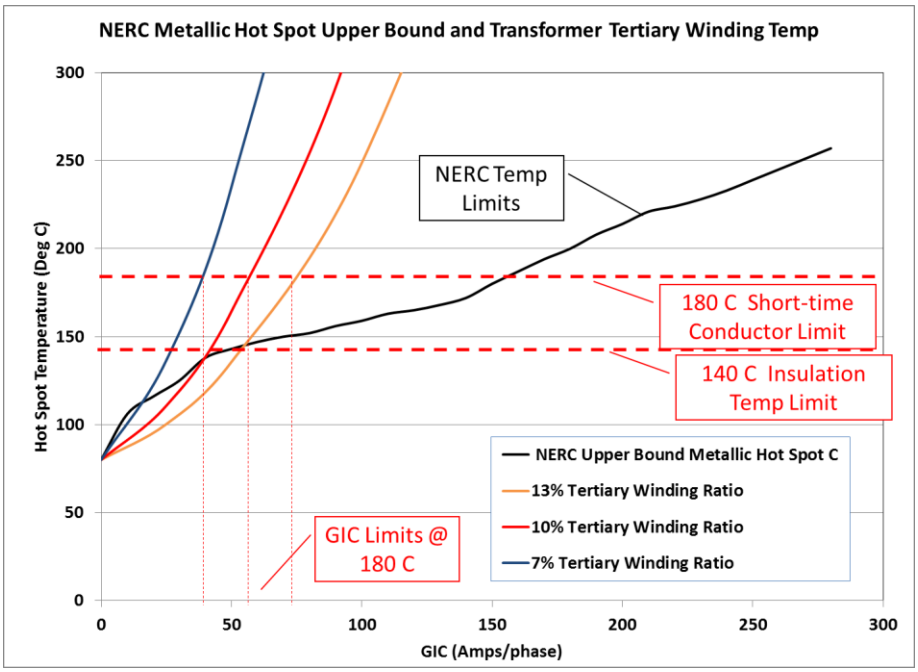


Figure 3- Plot of NERC Table 1 & Ignored Tertiary Winding Conductor Temperatures

In the case of autotransformers, the tertiary windings are usually unloaded. The GIC will cause the occurrence of harmonic circulating currents in the windings and lead to damaging temperature increases. Hence there is no available operating procedure to unload these windings as a means to prevent this damage, except for purposely tripping all such exposed transformers which will lead to concerns about hastening grid blackout conditions.

Failure of the NERC Standards Drafting Team and NERC GMD Task Forces to Gather Relevant GIC Data and Validate Hundred Year Storm Models

The NERC Standard has devised a formulation of the Peak Geo-Electric field that has been described via the formula given in Figure 4. The NERC Standard Drafting team has made numerous statements that this formulation provides a "Hundred Year" threat level and was noted by the SDT Team during the course of balloting of the standard. ("*the SDT believes a 100-year scenario is an appropriate benchmark."*)

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

Figure 4 - NERC Standard Peak Geo-Electric Field Formula

As commenters to this standard have noted, there are a number of fundamental problems with this formulation which can be summarized as follows:

- 8 Volts/km multiplier – which is the first constant in the above equation. Concern that Models do not Estimate this Constant Correctly due to Unsubstantiated Hot Spot Averaging or other unexplained techniques by the NERC SDT reducing a previously estimated 50 V/km peak geo-electric field by SDT Team members[4] to 8 V/km – a greater than Factor of 6 de-rate that cannot and has not be substantiated.
- Alpha Factor - Factor Based on NERC Storm Intensity Profile, Threat Levels are Too Low and can be shown that a number of observations since 1972 greatly exceed the thresholds provided in this profile
- Beta Factor - Factor Based on Regional Ground Conductivity Estimates, Ground Models are Un-Validated & Can Be Readily Checked against Existing GIC Data.
- Errors of Each Factor individually (the 8 V/km Constant, the Alpha and Beta) Being Too-Low Become Compounded, Greatly Increasing Overall Error.

Figure 5 provides a plot comparing the NERC Hundred Year Profile as a function of geomagnetic latitude (blue line) and represents the applied Alpha factor in the above equation. Also shown on this are observations in various storms and at various latitude locations which exceed this over the period since 1972, however most of these observations exceeding the NERC profile have occurred over the last ~30 years. In some cases, known observations exceed the NERC profile by more than a factor of two. In any case if the NERC Profile was a Hundred Year profile, then none of these observations should exceed the threshold blue line. These observations exclude the NERC profile from representing a Hundred Year profile. Further the prior NERC paper (by Pulkkinen/Bernabeu) and many other independent papers notes that a disturbance intensity of ~4000-5000 nT/min is likely for Hundred Year extremes. Hence the NERC Alpha is too low to represent this Hundred Year standard.

[4] A. Pulkkinen, Bernabeu, et.al., Generation of 100-year geomagnetically induced current scenarios, SPACE WEATHER, VOL. 10, S04003, doi:10.1029/2011SW000750, 2012

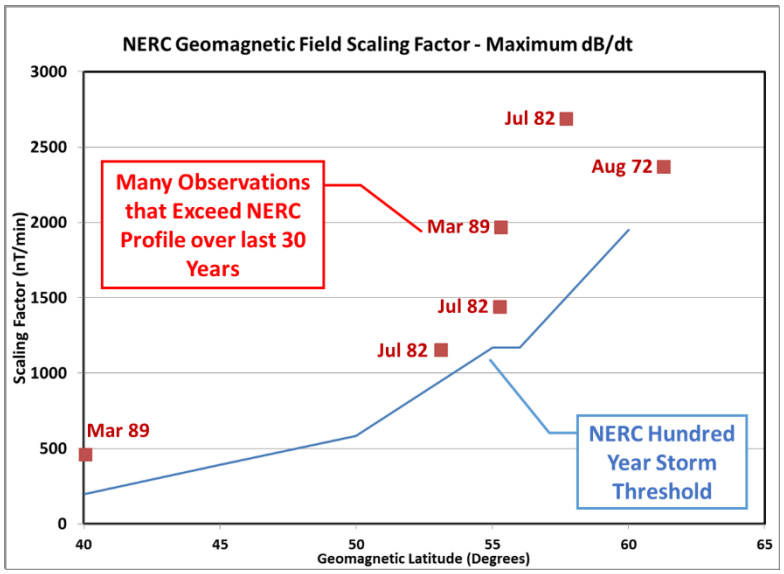


Figure 5 - NERC Hundred Year Storm Profile versus Recent Observations exceeding this profile

The Beta Factor which is determined by the local ground conductivity model response is also of concern. While the USGS assisted in the development of the regional ground models used in the US portion of the NERC model, Dr. Jennifer Gannon cautioned that these models had tremendous uncertainty with results that could vary by a factor of 3 to 4. She further urged the NERC GMD Task Force to conduct model validations with already available GIC observations to validate the models and assure of their accuracy.[5] None of these precautions have been undertaken by the NERC GMD Task Force or the NERC STD Team, rather the Draft Standard issued by the SDT Team reports to have ground model accuracy in the standard that is two significant digits after the decimal point. The NERC GMD Task Force and NERC SDT Team has not made any attempt to collect any GIC Data for utilization in the validation of NERC ground models. It is not at all possible given the uncertainties in these ground models that such a level of accuracy can now be claimed by the NERC SDT Team as being reliable in the draft standard. It has also been clearly established in the prior comments to the standard, that significant errors exist in the geo-electric field simulation models supplied by SDT Team member Pulkkinen and used to tune other versions of this model adopted and propagated by the NERC SDT Team.

Various tests of the reliability of the ground models using limited GIC data made available from non-NERC sources have shown that the NERC Models can and will under-predict the geo-electric field and GIC values significantly. The flawed NERC Beta factor reduces projected amps at the transformer neutral or amps per phase of transformers inconsistently with the actual data. This was pointed out in the set of data measurements recorded over twenty years at Chester, Maine, the nation's longest continuous time series for GIC measurements. These GIC measurements along with a number of other GIC measurements invalidates the benchmark model, as noted, but not adequately addressed by the NERC SDT Team, in the Kappenman-Radasky and Kappenman-Birnbach submissions.

The "8" multiplying factor used in the NERC Epeak formula is an important material alteration made by the NERC SDT Team, but also lacks any level of substantiation to support the usage of this constant. As

[5] Dr. Jennifer Gannon, USGS on Ground Conductivity Model Uncertainty, presentation to NERC GMD Task Force on Nov 14, 2013

established in prior NERC publications, this constant could be as high as “50”, but has been now reduced to “8”. The NERC SDT Team in the spring of 2014 (prior to the beginning of the Standards Balloting process) has only offered the statement that Antti Pulkkinen, Emanuel Bernabeu, (NERC SDT Team members) and coauthors have revised previous work (Pulkkinen et al. 2012) on modeling 100-year storm scenarios in part by factoring in that most places won’t experience the magnetic extremes that characterize the scenario. The details of this are an important driver of the NERC Draft Standard but have been withheld from public scrutiny during the entirety of the balloting period for this standard. This paper and the material information contained in this paper have still not been made publicly available. The NERC SDT Team decision to withhold such important material information from public scrutiny throughout the Standards Balloting Process is a critical procedural error. The veracity of this change could not be evaluated or fully commented on during the balloting process.

Conclusions

As this summary notes, there have been a large number of significant procedural errors on the part of NERC in the development of this standard. These errors point towards significant engineering omissions in the correct consideration of impacts of future geomagnetic storms to the electric power grid and critical apparatus in the interconnected power grid. Further there are significant scientific procedural errors that provide unsubstantiated reductions in storm and geo-electric field threat levels. These reductions are also inconsistent with both empirical data observations and prior scientific consensus of the threat levels. There are also significant data that is known to exist within the electric power industry and organizations such as EPRI which has not been collected by NERC or examined forensically. This raises the important question of how can any standard be trusted if it does not relate to reality or is checked against reality and data that is known to exist. The Standard comment record clearly establishes that the various and limited GIC observations that have come into the public domain (without NERC action) show that the NERC standard can greatly under-predict and understate the seriousness of this threat to the power grid and society.

These independent examinations that have been provided via comments to the standard supports the concerns that the NERC standard will inadequately protect the power grid and society from future geomagnetic storms. These are significant procedural errors on the part of NERC that will result in further unsound engineering practices and unsound scientific investigation and analysis as the industry follows this standard. This is not in the interest of society or those who provide engineering services and equipment to the electric power industry.

While the NERC standard, even if flawed as it is in the current state, is somehow approved by the FERC, then that may extend to NERC and its members (specifically electric utilities and power generation companies), a safe harbor protection from negligence liability, even gross negligence. However, already existing comments and information that are publicly available illustrate that the NERC standard is flawed, inadequate, and cannot be or has not been substantiated in important various scientific and engineering deficiencies. Further this flawed standard will invite added scientific scrutiny to further reinforce the nature of the flaws and deficiencies in the standard. Also, future storm events themselves will expose that these standards were quite inadequate.

In contrast, all independent professional engineering and scientific services firms/consultants and power industry equipment manufacturers will not enjoy the same legal liability protection that would be available to NERC or electric utility members. Therefore these firms would have considerable reluctance to enter into work providing professional services and/or equipment to support industry in meeting the minimum requirements of the flawed standard. If they did such work, they would subject themselves to legal liabilities including not just simple but also gross negligence in acting to support such a flawed standard. Further these liabilities could expose these firms to both significant civil as well as criminal legal consequences. This will also have unintended negative consequences for the electric power industry (NERC members) in that they would find themselves unable to procure the best practitioners for these related engineering and scientific services.

June 8, 2015

Mr. Kenneth G. Peterson, Chair
Level 2 Appeals Panel, Board of Trustees
North American Electric Reliability Corporation
3353 Peachtree Road, N.E.
Atlanta, Georgia 30326

Dear Mr. Peterson:

Please add our organization as an additional party to the Level 2 Appeal of the Foundation for Resilient Societies on reliability standard TPL-007-001, "Transmission System Planned Performance for Geomagnetic Disturbance Events."

TPL-007-001 is a profoundly defective standard that directly endangers the lives of those in my organization. According to NASA, severe solar storms are not unforeseen or improbable events; the chance of a severe storm each decade is approximately 12%. A report produced by Oak Ridge National Laboratory concludes that a severe solar storm could cause long-term blackout for 130 million Americans. As a result of the high probability and catastrophic impact of solar storms, we have direct and material interests. We are adversely affected in our day-to-day lives, which are always at risk.

The NERC Standard Drafting Team failed collect relevant data, contrary to Section 6.0 of the NERC Standards Processes Manual, "Processes for Conducting Field Tests and Collecting and Analyzing Data." In particular, NERC did not collect available data on Geomagnetically Induced Current (GIC) and transformer failures. Effective quality control was impossible. This process failure was explained in the Level 1 Appeal of Resilient Societies and its incorporated references; see the attachment to this letter.

We find standard TPL-007-001 to be at odds with sound science and lacking support of real-world data. It's implementation by NERC could therefore be considered an act of gross negligence were a blackout with loss of life to occur. We respectfully request that the Level 2 Appeal Panel require the Standard Drafting Team to rework standard TPL-007-001 by collecting and using relevant data.

Sincerely,

Nicholas Hanlon
Center for Security Policy

Attachment: Group Comments on NERC Standard TPL-007-1
Transmitted electronically on June 8, 2015 to: spmappeal@nerc.net

Group Comments on NERC Standard TPL-007-1 – Transmission System Planned Performance for Geomagnetic Disturbance Events

November 21, 2014

Draft standard TPL-007-1, "Transmission System Planned Performance for Geomagnetic Disturbance Events," is not a science-based standard. Instead, the apparent purpose of standard TPL-007-1 is to achieve a preferred policy outcome of the North American Electric Reliability Corporation (NERC) and its electric utility members: avoidance of installation of hardware-based protection against solar storms. The draft standard achieves this apparent purpose through a series of scientific contrivances that are largely unsupported by real-world data. Potential casualties in the millions and economic losses in trillions of dollars from severe solar storms instead demand the most prudent science-based standard.

A 2010 series of comprehensive technical reports, "Electromagnetic Pulse: Effects on the U.S. Power Grid"[1] produced by Oak Ridge National Laboratory for the Federal Energy Regulatory Commission in joint sponsorship with the Department of Energy and the Department of Homeland Security found that a major geomagnetic storm "could interrupt power to as many as 130 million people in the United States alone, requiring several years to recover."

A 2013 report produced by insurance company Lloyd's and Atmospheric and Environmental Research, "Solar Storm Risk to the North American Electric Grid,"[2] found that:

> "A Carrington-level, extreme geomagnetic storm is almost inevitable in the future. While the probability of an extreme storm occurring is relatively low at any given time, it is almost inevitable that one will occur eventually. Historical auroral records suggest a return period of 50 years for Quebec-level storms and 150 years for very extreme storms, such as the Carrington Event that occurred 154 years ago."
>
> "The total U.S. population at risk of extended power outage from a Carrington-level storm is between 20-40 million, with durations of 16 days to 1-2 years. The duration of outages will depend largely on the availability of spare replacement transformers. If new transformers need to be ordered, the lead-time is likely to be a minimum of five months. The total economic cost for such a scenario is estimated at $0.6-2.6 trillion USD."

A 2014 paper published in the Space Weather Journal, "Assessing the impact of space weather on the electric power grid based on insurance claims for industrial electrical equipment"[3] by C. J. Schrijver, R. Dobbins, W. Murtagh, and S.M. Petrinec found:

> "We find that claims rates are elevated on days with elevated geomagnetic activity by approximately 20% for the top 5%, and by about 10%for the top third of most active days ranked by daily maximum variability of the geomagnetic field."
>
> "The overall fraction of all insurance claims statistically associated with the effects of geomagnetic activity is 4%."

"We find no significant dependence of the claims frequencies statistically associated with geomagnetic activity on geomagnetic latitude."

Given the extreme societal impact of a major solar storm and large projected economic losses, it is vital that any study by NERC in support of standard TPL-007 be of the highest scientific caliber and rigorously supported by real-world data. The unsigned white papers of the NERC Standard Drafting Team fail scientific scrutiny for the following reasons:

1. The NERC Standard Drafting Team contrived a "Benchmark Geomagnetic Disturbance (GMD) Event"[4] that relies on data from Northern Europe during a short time period with no major solar storms instead of using observed magnetometer and Geomagnetically Induced Current (GIC) data from the United States and Canada over a longer time period with larger storms. This inapplicable and incomplete data is used to extrapolate the magnitude of the largest solar storm that might be expected in 100 years—the so-called "benchmark event." The magnitude of the "benchmark event" was calculated using a scientifically unproven "hotspot" conjecture that averaged the expected storm magnitude downward by an apparent factor of 2-3. This downward averaging used data collected from a square area only 500 kilometers in width, despite expected impact of a severe solar storm over most of Canada and the United States.
2. The NERC Standard Drafting Team contrived a table of "Geomagnetic Field Scaling Factors" that adjust the "benchmark event" downward by significant mathematical factors dependent on geomagnetic latitude. For example, the downward adjustment is 0.5 for Toronto at 54 degrees geomagnetic latitude, 0.3 for New York City at 51 degrees geomagnetic latitude, and 0.2 for Dallas at 43 degrees geomagnetic latitude. These adjustment factors are presented in the whitepaper in a manner that does not allow independent examination and validation.
3. The NERC Standard Drafting Team first contrived a limit of 15 amps of GIC for exemption of high voltage transformers from thermal impact assessment based on limited testing of a few transformers. When the draft standard failed to pass the second ballot, the NERC Standard Drafting Team contrived a new limit of 75 amps of GIC for exemption of transformers from thermal impact assessment, again based on limited testing of a few transformers. The most recent version of the "Screening Criterion for Transformer Thermal Impact Assessment"[5] whitepaper uses measurements from limited tests of only three transformers to develop a model that purports to show all transformers could be exempt from the thermal impact assessment requirement. It is scientifically fallacious to extrapolate limited test results of idiosyncratic transformer designs to an installed base of transformers containing hundreds of diverse designs.

The above described contrivances of the NERC Standard Drafting Team are unlikely to withstand comparison to real-world data from the United States and Canada. Some public GIC data exists

for the United States and Canada, but the NERC Standard Drafting Team did not reference this data in their unsigned whitepaper "Benchmark Geomagnetic Disturbance Event Description." Some public disclosures of transformer failures during and shortly after solar storms exist for the United States and Canada, but the NERC Standard Drafting Team did not reference this data in their unsigned whitepaper "Screening Criterion for Transformer Thermal Impact Assessment."

NERC is in possession of two transformer failure databases.[6] [7] This data should be released for scientific study and used by the NERC Standard Drafting Team to develop a data-validated Screening Criterion for Transformer Thermal Impact Assessment. The NERC Standard Drafting Team failed to conduct appropriate field tests and collect relevant data on transformer failures, contrary to Section 6.0 of the NERC Standards Processes Manual, "Processes for Conducting Field Tests and Collecting and Analyzing Data."[8]

U.S. and Canadian electric utilities are in possession of GIC data from over 100 monitoring locations, including several decades of data from the EPRI SUNBURST system.[9] This GIC data should be released for scientific study and used by the NERC Standard Drafting Team to develop a data-validated Benchmark Geomagnetic Disturbance Event. The NERC Standard Drafting Team failed to conduct appropriate field tests and collect relevant data on measured GIC, contrary to Section 6.0 of the NERC Standards Processes Manual, "Processes for Conducting Field Tests and Collecting and Analyzing Data."[10]

The NERC whitepaper "Benchmark Geomagnetic Disturbance Event Description" contains "Appendix II – Scaling the Benchmark GMD Event," a system of formulas and tables to adjust the Benchmark GMD Event to local conditions for network impact modeling. Multiple comments have been submitted to the Standard Drafting Team showing that the NERC formulas and tables are inconsistent with real-world observations during solar storms within the United States.[11] [12] [13] While the NERC Standard Processes Manual requires that the Standard Drafting Team "shall make an effort to resolve each objection that is related to the topic under review," the Team has failed to explain why its methodology is inconsistent with measured real-world data.[14]

Even the most rudimentary comparison of measured GIC data to the NERC "Geomagnetic Field Scaling Factors" shows the methodology of "Appendix II—Scaling the Benchmark GMD Event" of whitepaper "Benchmark Geomagnetic Disturbance Event Description" is flawed. For example, this comment submitted in standard-setting by Manitoba Hydro:

> "GMD Event of Sept 11-13, 2014 - EPRI SUNBURST GIC data over this period suggests that the physics of a GMD are still unknown, in particular the proposed geoelectric field cut-off is most likely invalid. Based on the SUNBURST data for this period in time one transformer neutral current at Grand Rapids Manitoba (above 60 degrees geomagnetic latitude) the northern most SUNBURST site just on the southern edge of the auroral zone only reached a peak GIC of 5.3 Amps where as two sites below 45 degrees geomagnetic latitude (southern USA) reached peak GIC's of 24.5 Amps and 20.2 Amps. "[15]

In the above instance, if the NERC "Geomagnetic Field Scaling Factors" were correct and all other factors were equal, the measured GIC amplitude at 45 degrees geomagnetic latitude should have been 1 Amp (5.3 Amps times scaling factor of 0.2). Were other GIC data to be made publicly available, it is exceedingly likely that the "Geomagnetic Field Scaling Factors" would be invalidated, except as statistical averages that do not account for extreme events. Notably, the above observation of Manitoba Hydro is consistent with the published finding of C. J. Schrijver, et. al. that "We find no significant dependence of the claims frequencies statistically associated with geomagnetic activity on geomagnetic latitude."

The EPRI SUNBURST database of GIC data referenced in the above Manitoba Hydro comment should be made available for independent scientific study and should be used by the NERC Standard Drafting Team to correct its methodologies.

American National Standards Institute (ANSI)-compliant standards[16] are required by the NERC Standard Processes Manual. Because the sustainability of the Bulk Power System is essential to protect and promptly restore operation of all other critical infrastructures, it is essential that NERC utilize all relevant safety and reliability-related data supporting assessments of geomagnetic disturbance impacts on "critical equipment" and benefits of hardware protective equipment. Other ANSI standards depend upon and appropriately utilize safety-related data on relationships between structural design or protective equipment and the effective mitigation of earthquakes, hurricanes, maritime accidents, airplane crashes, train derailments, and car crashes.

Given the large loss of life and significant economic losses that could occur in the aftermath of a severe solar storm, and the scientific uncertainly around the magnitude of a 1-in-100 solar storm, the NERC Standard Drafting Team should have incorporated substantial safety factors in the standard requirements. However, the apparent safety factor for the "Benchmark GMD Event" appears to be only 1.4 (8 V/km geoelectric field used for assessments vs. 5.77 V/km estimated).

The NERC Standard Processes Manual requires that the NERC Reliability Standards Staff shall coordinate a "quality review" of the proposed standard.[17] Any competent quality review would have detected inconsistencies between the methodologies of the "Benchmark Geomagnetic Disturbance Event Description" and real world data submitted in comments to the Standard Drafting Team. Moreover, any competent quality review would have required that the Standard Drafting Team use real-world data from the United States and Canada, rather than Northern Europe, in developing the methodologies of the "Benchmark Geomagnetic Disturbance Event Description" and "Screening Criterion for Transformer Thermal Impact Assessment."

Draft standard TPL-007-1 does not currently require GIC monitoring of all high voltage transformers nor recording of failures during and after solar storms.[18] These requirements should be added given the still-developing scientific understanding of geomagnetic disturbance phenomena and its impact on high voltage transformers and other critical equipment.

Going forward, data on observed GIC and transformer failures during solar storms should be publicly released for continuing scientific study. NERC can and should substitute a science-based standard to model the benefits and impacts on grid reliability of protective hardware to prevent long-term blackouts due to solar geomagnetic storms.

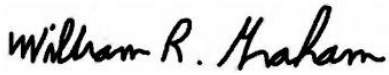
Submitted by:

Thomas S. Popik
Chairman
Foundation for Resilient Societies

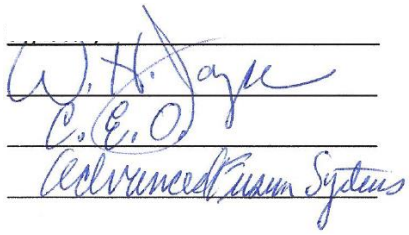
William R. Harris
International Lawyer
Secretary, Foundation for Resilient Societies

Dr. George H. Baker
Professor Emeritus, James Madison University
Director, Foundation for Resilient Societies

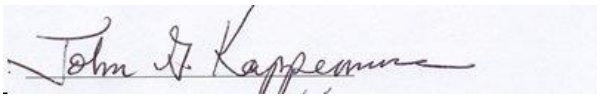
Representative Andrea Boland
Maine State Legislature
Sanford, ME (D)



Dr. William R. Graham
Chair of Congressional EMP Commission and
former Assistant to the President for Science and Technology
Director, Foundation for Resilient Societies



William H. Joyce
Chairman and CEO
Advanced Fusion Systems



John G. Kappenman
Owner and Principal Consultant
Storm Analysis Consultants, Inc.

Alberto Ramirez O.
Principal
Resilient Grids LLC
1531 Alton Rd
Miami FL 33139

Endnotes:

[1] "Electromagnetic Pulse: Effects on the U.S. Power Grid," Oak Ridge National Laboratory (June 2010) available at http://web.ornl.gov/sci/ees/etsd/pes/pubs/ferc_Executive_Summary.pdf.
[2] "Solar Storm Risk to the North American Electric Grid," Lloyd's and Atmospheric and Environmental Research (2013) available at https://www.lloyds.com/~/media/lloyds/reports/emerging%20risk%20reports/solar%20storm%20risk%20to%20the%20north%20american%20electric%20grid.pdf.
[3] "Assessing the impact of space weather on the electric power grid based on insurance claims for industrial electrical equipment," C. J. Schrijver, R. Dobbins, W. Murtagh, and S.M. Petrinec (June 2014) available at http://arxiv.org/abs/1406.7024.
[4] "Benchmark Geomagnetic Disturbance Event Description," NERC Standard Drafting Team (October 2014) available at http://www.nerc.com/pa/Stand/Project201303GeomagneticDisturbanceMitigation/Benchmark_GMD_Event_Oct28_clean.pdf.
[5] "Screening Criterion for Transformer Thermal Impact Assessment," NERC Standard Drafting Team (October 2014) available at http://www.nerc.com/pa/Stand/Project201303GeomagneticDisturbanceMitigation/GMD_Thermal_screening_Oct27_clean.pdf.
[6] "Generating Availability Data System (GADS)," NERC (Undated) available at http://www.nerc.com/pa/RAPA/gads/Pages/default.aspx.
[7] "Transmission Availability Data System (TADS),"NERC (Undated) available at http://www.nerc.com/pa/RAPA/tads/Pages/default.aspx.
[8] "Standard Processes Manual, Version 3," NERC (June 26, 2013), page 28, available at http://www.nerc.com/comm/SC/Documents/Appendix_3A_StandardsProcessesManual.pdf.
[9] "SUPPLEMENTAL INFORMATION SUPPORTING REQUEST FOR REHEARING OF FERC ORDER NO. 797, RELIABILITY STANDARD FOR GEOMAGNETIC DISTURBANCE OPERATIONS, 147 FERC ¶ 61209, JUNE 19, 2014 AND MOTION FOR REMAND," Foundation for Resilient Societies (August 2014) available at http://www.resilientsocieties.org/images/Resilient_Societies_Additional_Facts081814.pdf.
[10] "Standard Processes Manual, Version 3," NERC (June 26, 2013), page 28, available at http://www.nerc.com/comm/SC/Documents/Appendix_3A_StandardsProcessesManual.pdf.
[11] Comment of, "Examination of NERC GMD Standards and Validation of Ground Models and Geo-Electric Fields Proposed in this NERC GMD Standard," J. Kappenman and W. Radasky (July 30, 2014) available at http://www.nerc.com/pa/Stand/Project201303GeomagneticDisturbanceMitigation/WhitePaper_NERC_Model_Validation_07302014.pdf.
[12] "Comments of John Kappenman & Curtis Birnbach on Draft Standard TPL-007-1," J. Kappenman and C. Birnbach (October 10, 2014), available at http://www.nerc.com/pa/Stand/Project201303GeomagneticDisturbanceMitigation/GMD_comments_received_10152014_final.pdf.
[13] "Response to NERC Request for Comments on TPL-007-1," Foundation for Resilient Societies (October 10, 2014) available at http://www.nerc.com/pa/Stand/Project201303GeomagneticDisturbanceMitigation/GMD_comments_received_10152014_final.pdf.
[14] Standard Processes Manual, Version 3," NERC (June 26, 2013), page 4, available at http://www.nerc.com/comm/SC/Documents/Appendix_3A_StandardsProcessesManual.pdf, page 4.
[15] "Comment of Manitoba Hydro" Joann Ross, (October 10, 2014), http://www.nerc.com/pa/Stand/Project201303GeomagneticDisturbanceMitigation/GMD_comments_received_10152014_final.pdf.

[16] "American National Standards Institute, Essential Requirements: Due process requirements for American National Standards," ANSI (January 2014) available at: http://publicaa.ansi.org/sites/apdl/Documents/Standards%20Activities/American%20National%20Standards/Procedures,%20Guides,%20and%20Forms/2014_ANSI_Essential_Requirements.pdf .

[17] "Standard Processes Manual, Version 3," NERC (June 26, 2013), page 20, available at http://www.nerc.com/comm/SC/Documents/Appendix_3A_StandardsProcessesManual.pdf.

[18] "TPL-007-1 — Transmission System Planned Performance for Geomagnetic Disturbance Events," NERC Standard Drafting Team (October 2014) available at http://www.nerc.com/pa/Stand/Project201303GeomagneticDisturbanceMitigation/tpl_007_1_20141027_clean.pdf.

Comments on TPL-007 Level 2 Appeal by Resilient Societies, Inc.

The Tennessee Valley Authority has been an active participant in NERC activities that resulted in the proposed Draft Standard TPL-007, and voted affirmatively in the final ballot of December 16, 2014.

We recommend that the Level 2 Appeals Panel decline this appeal. TVA supports NERC's response of February 18, 2015, to the Level 1 Appeal by Resilient Societies, Inc., in which NERC concludes that the procedures of NERC's Standard Processes Manual were correctly followed.

NERC's Appeal Process correctly excludes any consideration of technical issues in a proposed Standard, which is appropriate since a substantial majority of voting members have supported the Standard in an affirmative vote. Nonetheless, TVA notes that the NERC Standard Drafting Team for TPL-007 performed very substantial and sophisticated technical analyses to enable the industry to address poorly understood physical events, developing justifiable and conservative Standard Requirements which avoid potential for excessive and possibly harmful investments while limiting risk and ensuring that the industry will develop technical studies to ensure that future Requirements are based on appropriate priorities. TVA also notes that it presently has ten GIC detectors, not four as stated in the appeal, and that TVA GIC data is available to the industry on request.

From: Peter Pry <peterpry@verizon.net>
Sent: Monday, June 08, 2015 3:45 PM
To: SPMappeal
Subject: Comments - Level 2 Appeal of Foundation for Resilient Societies, Inc.

This supports the appeal by the Foundation for Resilient Societies criticizing the geomagnetic disturbance (GMD) standard submitted by NERC to protect the electric grid from solar storms. The GMD Standard is based on junk science, is not consistent with real world data about known solar storms, and makes false assumptions about the survivability of EHV transformers exposed to a severe solar storm. I served for several years as an observer on the NERC GMD Task Force and witnessed first hand NERC's intellectual dishonesty as it "cooked the books" to invent the current GMD Standard--which will have the net effect of requiring industry to do little or nothing to protect the grid from solar storms. For example, NERC made no effort to collect data on the effects of GMD on transformers, and tried hard to advance the false claim that a transformer damaged by GMD during the 1989 Hydro-Quebec geo-storm was not really damaged by GMD. I concur completely with the critique of the GMD Standard submitted by Mr. John Kappenman and Dr. William Radasky, former members of the Congressional EMP Commission, who have far more expertise on these matters than anyone in U.S. FERC, NERC, or the electric power industry as a whole. I recently testified to the House Committee on Oversight and Government Reform that the U.S. FERC-NERC process is so dysfunctional--because it produces outcomes like this phoney GMD Standard--that both organizations should be abolished, and a new independent USG agency established, or an alternative agency like DHS given the responsibility, of ensuring that the national electric grid is survivable against such threats as GMD, EMP, Cyber Attack, and severe weather.

Dr. Peter Vincent Pry
Executive Director
EMP Task Force on National and Homeland Security
540-894-5742
301-481-4715

From: Braveheart,Cain (CONTR) - TG-DITT-2 <rcbraveheart@bpa.gov>
Sent: Monday, June 08, 2015 7:24 PM
To: SPMappeal
Cc: TRSG Standards Coordination
Subject: Comments - Level 2 Appeal of Foundation for Resilient Societies, Inc.

Hello,

BPA is concerned that the Foundation for Resilient Societies, Inc. (Foundation) may be working from a misunderstood data source regarding its assertion that NERC's impact data was incorrect. Additionally, BPA believes the Foundation cannot claim to be aggrieved simply because the Standard does not require Registered Entities to purchase protection equipment. The Foundation also has a close relationship with the manufacturer of proposed device solution, creating a possible conflict of interest.

Thank you,

Cain Braveheart

David Evans and Associates, Inc.
Program Support Specialist
Transmission Reliability Standards Group
Bonneville Power Administration
Office: 360-418-2132
rcbraveheart@bpa.gov

From: James Ference <jeference@gmail.com>
Sent: Monday, June 08, 2015 7:56 PM
To: SPMappeal
Subject: TPL-007-1 comment

Dear Sirs:
I would like to submit a letter of opposition to what appears to be a poorly constructed standard related to the "GIC withstand limit" related to transformer survival during a solar or otherwise induced geomagnetic current. I am disappointed that (the) NERC has shown relatively low regard for what could be a severe threat to the well-being of our nation. As a practicing health care professional, I am very aware of the huge implications that would occur related to a prolonged deficit in the functioning of the electric grid.
The very high standard for public safety that should be set is not being responsibly addressed by the institutions in positions of "authority".
It is not the intent of this letter to address the details of these apparent deficiencies, but it is rather a letter of opposition to the existing process that allows such faulty "solutions" to possibly be made into policy.
I would request that NERC revisit the process and reconsider these recommendations.
Sincerely,
James E. Ference DMD
213 Luther Rd.
Johnstown, Pa. 15904