

**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)	

SUPPLEMENTAL COMMENTS AND PETITION OF THE FOUNDATION FOR RESILIENT SOCIETIES

Submitted to FERC on September 10, 2015
Relating to the Level 2 NERC Appeal
In regard to Inadequacy of Quality Control and Non-Use of Scientific Method

Introduction

Pursuant to the Federal Energy Regulatory Commission’s (“FERC” or “Commission”) Notice of Proposed Rulemaking (“GMD NOPR”) issued on May 16, 2015,¹ the Foundation for Resilient Societies (“Resilient Societies”) respectfully submits Supplemental Comments on the Commission’s proposal to approve the framework of Reliability Standard TPL-007-1 of the North American Electric Reliability Corporation (NERC) as “just and reasonable,” to approve specific requirements of the standard, and to direct NERC to develop modifications to Reliability Standard TPL-007-1 and submit informational filings. We also petition FERC to place a report and viewgraphs briefed to FERC by the Los Alamos National Laboratory on GMD effects on the North American Electric Grid in FERC Docket No. RM15-11-000 for Commission consideration and for public comment.

Background

Following the July 27, 2015 deadline for the filing of Comments on the Commission’s Notice of Proposed Rulemaking, NERC filed with the Commission on August 17, 2015 the “Level 2 Appeal”

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).

Decision of a Subcommittee of the Board of Trustees.² NERC did not, however, file the Transcript of the June 29, 2015 Level 2 Appeals Hearing so we are separately filing the NERC-prepared Transcript.

Three days after NERC filed the NERC Level 2 Appeals decision in this Docket, the Secretary of the Commission on August 20, 2015 issued a “Notice Setting [a Supplemental] Comment Period”:

On August 17, 2015, the North American Electric Reliability Corporation (NERC) filed in the above-captioned docket a NERC appeal panel’s decision addressing the Foundation for Resilient Societies, Inc. “Level 2 Appeal” regarding the development of proposed Reliability Standard TPL-007-1 (Transmission System Planned Performance for Geomagnetic Disturbances). Comments regarding the Level 2 Appeal decision are due within 21 days of this notice.

Supplemental Comments and Petition of Resilient Societies

Resilient Societies appreciates the opportunity to file supplemental comments regarding the NERC Level 2 Appeal decision. The full transcript is incorporated by reference *in toto* as part of these Supplemental Comments:

North American Electric Reliability Corporation, [Transcript of NERC Level 2 Appeal of Procedures & Quality Control for Geomagnetic Disturbance Standard, June 29, 2015](#), August 17, 2015. 28 pp.

In addition to filing the full Transcript of the Level 2 Appeal in this Docket, we also refile the Resilient Societies’ Comments of July 27, 2015 as Corrected and refiled on August 10, 2015.

Foundation for Resilient Societies, [Corrected Comments on Reliability Standard TPL-007-1 \(Standard for Geomagnetic Disturbance Hardware Assessment\)](#), filed July 27, 2015, as Corrected, August 10, 2015. 91 pp.

² See FERC Submittal 20150817-5285, “Conclusion of Standard Process Appeal ...Transmission System Planned Performance for Geomagnetic Disturbance Events”.

The August 10, 2015 Corrected Comments previously filed by Resilient Societies address many of the same issues raised in the Level 2 NERC Appeal and rejected by decision of the NERC Trustee Subcommittee. So they are pertinent to the Level 2 Appeal decision, and are now timely filed in this Docket.³

From our perspective, the NERC filings at the Level 1 level (Jan 5-6, 2015), combined with the NERC Level 2 Appeal record and NERC Level 2 Appeal decision has implications for the scope of appropriate remand by the Commissioners.

NERC might have remanded to the Office of the Director of Standards at NERC the reconstitution of the GMD TPL-007-1 Standard Drafting Team to at least expedite inclusion of entirely missing elements of the NERC Benchmark Model for assessing equipment vulnerability and hardware-based mitigation options.

Missing elements of a scientifically-testable and validated GMD model, that the NERC Appeals Panel decided not to remand for model improvement, should include:

- The “coastal effect”; And the “coastal effect” combined with the “end-of-line” and “total transmission system length” elements of GMD vulnerability⁴;
- “Vibration effects” that place high voltage transformers at risk of failure at lower solar storm intensities than failures from thermal impacts⁵.

³ Our concern that our August 10, 2015 filing be treated as “timely filed” relates to the Commission’s prior decision to reject, as untimely filed, the submission of the locations and likely effective range of GIC monitors. See Federal Energy Regulatory Commission, [Order No. 797-A, Denying Rehearing, Reliability Standard EOP-010-1, Geomagnetic Disturbance Operations](#), Docket No. RM14-1-001, October 16, 2014, 149 FERC ¶ 61,027. The mandatory use and data sharing for operational GIC monitors, of which there are now well more than the 104 monitors we earlier identified, are the best hope for scientific modeling, model validation and quality control review of standards to assess and protect critical equipment during and after severe GMD events.

⁴ For a summary of the “Coastal Effect” in combination with Electrical System Boundaries, see Resilient Societies, Corrected Comment, August 10, 2015 section on “Electric System Boundaries and Coastal Effects,” at pp. 32-36 and footnotes 33 through 42. See also discussion of Bonneville Power Administration experience with East-West coastal effects even in transmission systems under 200 kV, at p. 52 and footnote 55, quoting a PowerWorld modeling study released under FOIA and included separately in this Docket.

⁵ It is our understanding that the IEEE Power Transformer Subcommittee referenced in a Docket filing by David Jonas Bardin does include concerns about vibration hazards to high voltage transformers; NERC should have and still should include this element of transformer damage, which Idaho National Laboratory has demonstrated to be significantly remedied by application of neutral ground blocking equipment.

- VaR requirements for regional electric grids, with and without installation of protective equipment that, by removing GICs from transmission systems, reduce both demand for reactive power (VaR) and risks of insufficient VaR and resulting voltage collapse⁶; and
- Harmonic effects of GICs, impacting not only high voltage transformers but also generators, turbines, and other grid equipment.⁷

The NERC TPL-007-1 Documentary Record for the Level 2 Appeal includes at pp. 8-11, a section, including referenced citation, to “Failure to include Magnetostriction and other Vibrational Risks to Operability of Transformers, Stators, Turbines, and other Grid Equipment.” See also Documentary Record at 11 (citations to Chinese modeling of vibrational risks in 500 kV transmission systems). NERC concedes that “vibration impacts are not included in the standard.” TPL-007-1 Documentary Record at p. 251, claiming despite widely published models and peer reviewed articles cited that “available information is sparse and mostly anecdotal.”

In its Corrected Comments of August 10, 2015, Resilient Societies provides an overview of “Vibrational Effects at Lower GIC Thresholds than Thermal Effects,” at pp. 36-38. At page 37 we note that NERC failed to consult its own NERC file from year 1990 on widespread noise associated with vibrations of high voltage transformers during the March 1989 solar storm. At pages 37-38, we noted the testing of DC current injections into a 138 kV test transmission system, causing vibrations; and the termination of the vibrations when a neutral ground blocker was switched on; and the comment of Scott McBride: “Watching a 150,000-pound transformer visibly vibrating and moving along the ground during a simulated solar event... is a sobering sight.”

In the Level 2 NERC Appeal, a national expert on modeling transformer vulnerabilities, John Kappenman, asked the NERC Appeals Panel, as one of needed remedies, for “evaluation of the impacts of vibration on transformers, not just thermal screening.” TR17 lines 20-21. FERC has authority to require that outcome since NERC has rejected a key element of vulnerability modeling.

In contrast, Frank Koza, chair of the Standard Development Team, claimed, without citing any supporting literature, that as for “transformer vibration: Right now, at least where the research and the industry is, is that there is .. not at this point been established a firm relationship between vibration or even sound in the geomagnetic parameters.... So, as I understand that this is a topic of active research, the issue of whether vibration will lead to the transformer failures” TR19: lines 16-21.

⁶ Resilient Societies requested NERC to remand to include in the Benchmark Model estimates of VaR consumption. See NERC Documentary Record at 3. For Resilient Societies’ Comments on “Voltage Collapse and Reactive Power Modeling,” see Corrected Comments, Aug. 10, 2015, at pp. 42-45, and Table 7, List of Reactive Power Resources, 100-200 kV, in the United States, p. 51.

Resilient Societies highlighted NERC’s “Failure to include in the benchmark model methods to estimate VAR consumption and the consumption of VAR on voltage stability.” TR7: lines 3-4.

Frank Koza, Chair of the Standards Drafting Team, claimed with respect to VAR consumption that “The standards in general are not intended to address how calculations are to be performed.... In the case of VAR consumption, the NERC GMD Task Force has prepared a number of work papers ... and that is available through registered entities....In addition, there are commercial tools available....” NERC Level 2 Appeal TR19: lines 3-15.

NERC does not, however, address the consequences for regional grid stability or instability if there are not protective devices installed to remove GICs and reduce VAR consumption, or if VaR equipment in the future trips off, as has often occurred in just moderate GMD events.

⁷ The NERC Documentary Record shows Resilient Societies expressed concern that NERC failed to address “risks posed by harmonic production”. Documentary Record at 2, 7, 9, 15. Emprimus also expressed concern about unprotected harmonic production. Documentary Record. SmartSense also expressed concern about NERC’s modeling failure to address mis-operation risks due to harmonic production. Documentary Record at p. 250.

In its corrected Comments of August 10th, Resilient Societies addressed “Disruptive Harmonic Production” at page 47, citing FERC Order No. 779 that notes “the creation of disruptive harmonics that can cause the sudden collapse of the Bulk-Power System.” Resilient Societies Corrected Comments, p. 47, Footnote 53 cites NERC’s own

Our greatest concern, however, is not that there are “missing elements” of an appropriate Benchmark GMD Event model, but that the overall model is not based upon scientific methods that validate with real-world data: avoiding collection and use of historical data on the frequency and magnitude of solar storms, avoiding selection of a true 1 in 100 year solar storm; avoiding collecting and utilizing data on transformer failures; and not utilizing the roughly one quarter century of GIC data collected within North America, largely via the EPRI SUNBURST database.

During the NERC Level 2 Appeal Hearing, Frank Koza stated with respect to utilization of GIC data: “... in terms of Standards development, it’s inappropriate for the standard drafting team to require those devices to be installed as part of the standard.”

Mr. Koza addressed:

“the issue of including actual historical GIC data. The standard as it exists today was based on a statistical analysis. It is, we believe it is the best available high-fidelity data set that’s available to develop this benchmark. We’ll acknowledge, yes, it is Northern European data. But it is the best available data that we had to develop the benchmark. It was developed through the standards process as specified in FERC’s order.”⁸

Now, I’ll say this about use of actual GIC data. We believe actual GIC data is not the appropriate method for establishing a continent-wide benchmark. The scientists generally agree that there is a local geomagnetic enhancement associated with space weather or so-called hotspots as was referenced by the Foundation’s presentation. But, GIC is a function of system topology and is inappropriate for a benchmark to be specified in a geoelectric field terms. So, we believe the benchmark that we use is the best data. We believe it

February 2012 Interim Report as acknowledging that harmonic production is associated with tripping of protective devices during GMD events.

During the NERC Level 2 Appeal Hearing, Mr. Popik noted “a failure to include in the benchmark model risks posed by harmonic current production and [upon] transformers and the impacts on generators and other equipment in the bulk power system. TR6: line 23; TR7: lines 1-2

A national expert on GMD damage to grid equipment, John Kappenman, asked as a NERC remedial action: “Number five, examination of impacts of harmonics on grid equipment and utility customers.” TR17: lines 22-23

Mr. Koza, Chair of the NERC Standard Drafting Team, conceded that “We did not specifically come up with, I’ll say, deterministic requirements for consideration of harmonics because the tools and expertise to conduct such analyses really are not widely available in industry.” TR. 18: lines 20-23.

If the “tools are not widely available” in industry, is this not the best case for NERC to have assembled the experts and to have developed a model that could have been shared with the industry, and validated via use of historical GIC and transformer failure databases?

⁸ TPL-007-1 Appeal TR20 lines 17-21.

meets the intent of the FERC order to potentially deal with severe impacts on the bulk power system caused by GMD events.⁹

To the contrary, Resilient Societies asserts that, to have a science based benchmark, it is necessary to validate any theoretical model with empirical data. And that a model designed for reliability standards in North America should be based upon the empirical data for North America, not Finland, and not Sweden.

We note that, in parallel with our comments filed on September 10, 2015, a separate set of comments are being filed by John Kappenman and Curtis Birnbach. They have now reviewed the so-called “Horton analysis” of records of GIC disturbances affecting the fossil fuel generating facility at Paradise, Kentucky, a facility operated by the Tennessee Valley Authority. Early NERC GMD Task Force presentations suggested that the Benchmark GMD Event model accurately tracked empirical GIC measurements at the Paradise generating facility. The retrospective re-analysis by Kappenman and Birnbach finds that the NERC model is not a good predictor of actual GICs, and, as might be expected, the NERC model under-estimates GIC.

So, we now have, from the Kappenman comment, additional facts in the record that indicate the NERC model might not be scientifically valid.

What if the NERC Benchmark GMD Event model is fundamentally flawed? With the methodology applied by the NERC Standard Drafting Team, no one would ever know if this were so, because empirical data from historical records is not to be utilized as a method of model validation.

In asking and answering this question, we hereby Petition FERC, by direction to its staff or by a *sua sponte* order, to place into the public record of FERC Docket No. RM15-11-000:

- The Briefing Viewgraphs provided to FERC Commissioners and/or FERC Staff by a team of scientists employed by the Los Alamos National Laboratory who in the Spring of 2015 briefed FERC Commissioners and/or FERC Staff on the geophysical modeling of

⁹ TPL-007-1 Appeal TR20, lines 22-23, and TR21, lines 1-7.

geomagnetic disturbances as these phenomena impact the North American electric grid; together with

- Any resulting report to the Office of Energy Supply and Electric Reliability (DOE) prepared circa June-July 2015 by a team at Los Alamos National Laboratory headed by Dr. Scott Backhaus that modeled the geophysics of geomagnetic disturbances upon the electric grid of North America; together with:
- Anonymized peer reviews of the Los Alamos Report on GMD impacts upon the North American electric grid.

Resilient Societies only learned about the Los Alamos National Laboratory research report on July 21, 2015. At that time the Office of Energy Supply and Electric Reliability was planning to file the Los Alamos Report in FERC Docket No. RM15-11-000 by the filing deadline of July 27, 2015. Reportedly, a decision was made to supplement two internal Los Alamos peer reviews with external peer review. So the Los Alamos Report was not timely-filed in FERC Docket RM15-11-000 on July 27th.

Based on our information and belief, the Los Alamos National Laboratory Report on the geophysics of GMD and impacts upon the North American electric grid has been completed, and has had at least four peer reviews.

We have notified the Office of Energy Supply and Electric Reliability that the FERC Docket RM15-11-000 is open through September 10, 2015, but as we file our Comments on September 10, 2015, we find no record of the Los Alamos Report being placed into the FERC Docket RM15-11-000.

Why is it in the public interest that the Los Alamos Report be placed into this FERC Docket?

First, the electric reliability standard development process is intended to be open, transparent, and balanced. Second, upon our information and belief, the Los Alamos National Laboratory research team may have identified a fundamental defect in the modeling done by the NERC Standard Drafting Team: specifically, the Benchmark GMD Event which uses a linear *alpha factor* may be in serious error and may significantly underestimate geoelectric fields at lower latitudes.

While we have not read the Los Alamos National Laboratory Report, nor the peer reviews of their work, we are alarmed if FERC proposes to accept the NERC Benchmark GMD Event model without placing the Los Alamos Briefing Viewgraphs and, if possible, the full Los Alamos Report in the publicly-accessible Docket, and without also enabling public comment on the Los Alamos Report.

What are the implications for public policy, if the NERC benchmark model is fundamentally flawed, and not validated by empirical data?

First, FERC may need to remand the NERC Benchmark GMD Event model for a fresh data collection and modeling effort.

Second, if the NERC Benchmark GMD Event model systematically underestimates the magnitude of the 1 in 100 year solar storm, the NERC model -- without a total remand -- will result in under-investment in necessary protections so the U.S. electric grid can promptly recover from a severe solar geomagnetic storm.

Third, if the NERC Benchmark GMD Event model results in limited or virtually no hardware protection for GMD hazards in the United States, this will have the unintended effect of creating major and needless barriers to protecting the U.S. electric grid from the hazards of man-made high altitude electromagnetic pulse (HEMP). Even if it is not FERC's goal to develop geomagnetic disturbance standards that protect from man-made EMP hazards, FERC should not adopt an arbitrary, capricious, unscientific GMD standard that will needlessly undermine deterrence of threats or actual employment of EMP weapons by potential foreign adversaries.

The reality is that if protective equipment, such as neutral ground blockers, is installed to protect high voltage transformers from GMD hazards, that the same protective equipment also protects against the E3 (slower, long line) hazards of man-made EMP. Extra high voltage transformers, depending upon design and installation of hardware protective equipment, may also have pre-existing protection against the ultra-fast E1 pulses from man-made EMP weapons.

A nation need not protect its entire grid from man-made EMP to enhance deterrence against EMP threats. But a nation that applies a fundamentally defective model for solar storm mitigation can inadvertently impair prospects for deterrence of man-made EMP hazards as well.

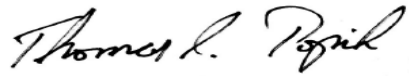
Our concern is not a speculative one. To bring this concern to the attention of the Commission and Docket participants, we include, as an Appendix to our Comments, the Prepared Remarks of the Chairman of the Congressional Caucus on Electromagnetic Pulse, Rep. Trent Franks of Arizona, presented in the U.S. House of Representatives Auditorium before delegates from 17 nations attending a conference in Washington on July 21, 2015.¹⁰ These comments indicate that the government of Iran has developed by year 2010 a military doctrine that favorably considers electromagnetic pulse (EMP) weapons as a viable military option.

For the previously noted reasons, we respectfully reiterate our prior request: that the Commission remand the proposed Reliability Standard TPL-007-1 in its entirety to NERC, with a mandate to develop a GIC monitoring network that can be utilized to develop science-based reliability standards.

And finally, we request that the FERC Commissioners place the Los Alamos Briefing Viewgraphs and text, if any, into the public record of Docket No. RM-15-11-000; and that the Commission request the release by the U.S. Department of Energy of the full Los Alamos Report, with anonymized peer reviews, so it can be filed in FERC Docket RM15-11-000.

¹⁰ Prepared Remarks, Rep. Trent Franks, Electric Infrastructure Security Summit VI, Washington, D.C. July 21, 2015. Included as an Appendix to these comments.

Respectfully submitted, by:



Thomas S. Popik, Chairman



William R. Harris, Secretary,

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**Appendix: Prepared Remarks of the Chairman of the Congressional
Caucus on Electromagnetic Pulse, Rep. Trent Franks of Arizona**

**Electric Infrastructure Security Council Summit
Prepared Remarks of
Rep. Trent Franks
July 21, 2015**

Well thank you all for having me back here today, it has been a true privilege to co-chair the previous 5 summits. I want to especially thank Avi Schnurr for putting these events together and his tireless efforts to help secure the electric grid from a wide range of threats.

It is so encouraging to see such a wide and growing variety of groups and sectors represented here today. Because threats to the electric grid are so complex, it takes all of us, from government to the private sector, working together to tackle such an enormous, but vital task.

The ultimate goal in protecting our critical electric infrastructure, and keeping our friends, families and future generations safe. We are gaining ground on many fronts, compared to when we started six years ago.

I am also encouraged by the passage of a bill I sponsored, the Critical Infrastructure Protection Act or CIPA which passed the house last year and has this year passed through the Homeland Security Committee facing a much more favorable environment in a Republican Senate this

year. CIPA is common sense legislation with one single goal in mind, help protect our nation's most critical infrastructure upon which 350 million Americans rely on daily

The Critical Infrastructure Protection Act will add large scale blackouts to our national planning frameworks which for the first time in American law, recognizes the threat that electromagnetic pulse represents to our civilian infrastructure. It sets into motion a comprehensive effort on the part of the Homeland Security Department to conduct comprehensive research into our vulnerabilities and mitigation options; and requires the Department of Homeland Security, working with all relevant sector-specific agencies, to create a recommended strategy to finally protect the civilian electric grid from geomagnetic disturbance and electromagnetic pulse.

There have been nearly a dozen federal government reports and studies on the threat and vulnerabilities that US critical infrastructure, most importantly the electric grid, faces from both electromagnetic pulse and geomagnetic disturbance. On the GMD side, space weather and NOAA scientists will tell you that is not a matter of if, but when, the US will get hit with another severe solar flare. A major "Carrington Class" storm hit Earth in 1859, and while a relatively minor solar storm

hit Quebec in 1989, it caused a blackout to their entire grid for nine hours which ended up killing 9 people.

As for the nuclear EMP threat, the National Intelligence University translated an Iranian military doctrine called Passive Defense from 2010 which emphasizes the importance of targeting critical infrastructure in warfare, and references 22 times the use of EMP as a weapon to damage or disable the civilian electric grids of potential opponents.

The Iranian doctrine states that Nuclear and non-nuclear EMP weapons operate differently but morally are the same. The conclusion of this doctrine is that nuclear EMP is "an advanced and useful weapon in modern "warfare" QUOTE *"As a result of not having the other destructive effects that nuclear weapons possess, among them the loss of human life, weapons derived from electromagnetic pulses have attracted attention with regard to their use in future wars...The superficiality of secondary damage sustained, as well as the avoidance of human casualties, serves as a motivation to transform this technology into an advanced and useful weapon in modern warfare."*

It's an interesting side note that the EMP Commission testified that Russian Generals had passed plans of how to build super-EMP weapons to North Korea, who have now tested 3 nuclear weapons.

Attacks to electric grids have happened all around the world. Geomagnetic disturbances have happened and can happen at any time. Unfortunately, when history repeats itself, the price of the lesson usually goes up. Given the reminders of yesterday's tabletop exercise module, we can all agree that the devastating nature of that worst-case scenario is something that simply must not happen. We are making great progress but we will not insulate ourselves from that worst-case scenario until we understand clearly the intensities of GMD and EMP we must protect against, create a national standard sufficient to withstand those intensities, and implement hardware based solutions that will enable our grid have a timely recovery in such an emergency.

I look forward to working with everyone in this room to ensure that goal.