

**TESTIMONY OF  
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TECHNICAL CONFERENCE ON  
GEOMAGNETIC DISTURBANCES TO THE BULK POWER SYSTEM  
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Thank you for the opportunity to participate in this technical conference on the NERC Report. I am Dr. Peter Vincent Pry, Executive Director of the Task Force on National and Homeland Security, that is newly established to advise Congress on natural and manmade EMP and other threats, and what to do about them. I have spent most of my professional life working on security issues and electromagnetic pulse effects, first at the CIA, then in the House Armed Services Committee, and nearly a decade on the Congressional EMP Commission.

The North American Electric Reliability Corporation (NERC) on February 29, 2012, released a report asserting that even a worst-case geomagnetic "super storm" like the 1859 Carrington Event or 1921 Railroad Storm would likely not damage most power grid transformers, but would principally cause voltage instability and possibly result in a blackout lasting hours or days, but not months or years.

NERC's assertions are not supported by any of the official studies performed by the U.S. Congress or the U.S. Government. Reports by the Congressional EMP Commission (2008), the National Academy of Sciences (2008), the Department of Energy and NERC itself in 2010 (*High-Impact, Low-Frequency Event Risk to the North American Bulk Power System*), the Federal Energy Regulatory Commission (2010), and most recently the Defence Committee of the British Parliament (2012)--all independently arrive at the scientific consensus that a great geomagnetic storm would cause widespread damage to power grid transformers, result in a protracted blackout lasting months or years, and have catastrophic consequences for society.

The Task Force on National and Homeland Security recently produced a report comparing the scientific methodology used in the industry-sponsored NERC Report with that used in one of the U.S. Government studies, the 2010 FERC Report. Our analysis finds that the FERC Report used a far more rigorous scientific methodology and arrived at better substantiated and more credible conclusions. **Therefore, the U.S. Government-sponsored FERC Report is recommended over the industry-sponsored NERC Report as a basis for making public policy.**

Our Task Force study comparing the scientific rigor of the FERC and NERC reports is appended to this testimony. I will briefly summarize some of the differences between the FERC and NERC reports, including key methodological differences that make the FERC Report analytically superior:

- The FERC Report concludes that power could be interrupted to as many as 130 million Americans for several years, while the NERC Report concludes that the most likely worst-case scenario is a blackout lasting hours or days.
- The FERC Report relied on a four-part quantitative model of geomagnetic disturbance effects on the U.S. power grid to develop conclusions and recommendations, while the NERC Report relied on meetings of industry employees in lieu of data collection or event investigation.
- The FERC Report was developed by a technical consultancy specializing in electromagnetic effects studies for the U.S. Department of Defense and was reviewed by multiple U.S. Government agencies, while the NERC Report was the product of a so-called Geomagnetic Disturbance Task Force with membership consisting only of representatives from electricity generation and transmission companies. In contrast to the FERC Report, no expert on geomagnetic storms and natural electromagnetic pulse (EMP) effects participated in actual drafting of the NERC Report.
- The FERC Report represents the consensus view of many scientists, laboratories, and U.S. Government agencies. In contrast, the NERC Report does not even represent the consensus judgment of its own GMD Task Force, but contradicts earlier GMD Task Force drafts, the final draft having been written in secret by a small group of NERC employees and electric utility insiders.
- The FERC Report employs a proven computer model to predict specific geographic areas expected to experience power grid collapse during a major geomagnetic disturbance, while the NERC Report discusses how such models might be developed in the future.
- The FERC Report predicts internal heating as a likely mechanism of transformer damage based on experience from actual geomagnetic disturbance events, while the NERC Report makes the extraordinary and unsupported claim that likely collapse of the power grid would prevent transformer overheating and damage.
- The FERC Report presents statistical research that the U.S. transformer fleet is on average over 30 years old and therefore is at risk to damage from internal heating during geomagnetic disturbance, while the NERC Report contains no statistical data on transformer age.
- The FERC Report contains a transformer-by-transformer assessment of equipment at risk during geomagnetic disturbance, while the NERC Report discusses how such an assessment might be performed in the future using "engineering judgment" and data from equipment manufacturers. The NERC Report's unsupported claim that a severe geo-storm is unlikely to result in a long-term blackout appears calculated to discourage any such future assessment.

- The FERC Report contains pictures of transformer damage at the Salem nuclear power plant in New Jersey in the aftermath of the same geomagnetic storm that caused the March 1989 Hydro-Quebec blackout, while similar pictures and corresponding data were removed from the published version of the NERC Report.

Another recent independent assessment of the NERC Report, by the Electric Infrastructure Security Council (EISC), finds that the NERC Report makes unsubstantiated assertions, lacks analytical rigor, and is demonstrably wrong on issues of vital importance to electric grid security from a severe geomagnetic storm. The EISC Report is appended to this testimony.

I will quote some of the key criticisms of the NERC Report made by the EISC Report.

The NERC Report asserts: "The most likely worst-case system impacts from a severe GMD [Geo-Magnetic Disturbance] event...is voltage instability caused by a significant loss of reactive power....NERC recognizes that other studies have indicated a severe GMD event would result in the failure of large numbers of EHV transformers. The work of the GMD Task Force documented in this report does not support this result..."

The EISC analysis of the NERC Report finds: *Upon careful review of the report, we were unable to find any supporting material for such a definitive claim, which appears to be a significant departure from all previous report drafts and, indeed, from all previous U.S. Government studies. We were disturbed to find that relevant data that could conflict with this conclusion has apparently been removed from the report, including photographs and other evidence of GMD transformer damage that appeared in previous report drafts.*

*Since the report's definitive, positive claim could discourage efforts to protect the U.S. from possible severe GMD-related grid damage, it must, of course, be backed up by extensive transformer data collection, review and corresponding detailed electrical and thermal modeling. While such data collection and analysis were identified as urgent needs in the deliberations of the task force, this effort has not yet taken place, or even initiated, to our knowledge. In fact, the above, definitive assertion in the report is likely to discourage any such effort....*

*Nothing cited in the report supports the claim that voltage instability is "most likely."*

Contrary to the NERC Report, the EISC Report finds that: ***There is no known evidence that voltage instability would be a worst case scenario.*** *While there is broad agreement among GMD Task Force members that GICs [Ground Induced Currents] would give rise to harmonic generation in transformers and increased reactive power losses, leading to voltage instability, there appears to be no basis for asserting that voltage instability is therefore the "worst case." The embedded implication seems to be that the grid would "self-protect" during a GMD event, with voltage instability causing a blackout before serious equipment damage occurs. This, however, is better described as a "best case" scenario compared to the actual "worst case" scenario where many transformers are damaged or destroyed.*

Contrary to the NERC Report, the EISC Report finds that: ***There is no evidence of grid "self-protection" in previous GMD events.*** *In fact, among the GMD events cited within the report,*

*there is no evidence of blackouts resulting in transformer protection. In the 1989 Storm, for example, the entire Quebec grid blacked out within 90 seconds due mostly to system instability. But even with a collapse this sudden, two transformers were still damaged. In the U.S. during the same storm, a transformer in New Jersey was destroyed with no accompanying voltage instability-induced blackout. During the 2003 Halloween storm in South Africa 14 transformers were damaged, with no blackout occurring during the storm itself.*

Contrary to the NERC Report, the EISC Report warns: ***Hoping for mutually compensating failures in a severe GMD event is not sound engineering practice.*** *It is, in any case, not normal engineering practice to count on mutually compensating accidents in the midst of a massive failure mode to compensate for known system vulnerabilities. Responsible engineering practice is to ensure critical systems have no single-point failures, and are inherently robust against known, severe risks.*

New concerns, heightened by the approaching solar maximum, over the possible recurrence of another great geomagnetic storm, like the 1859 Carrington Event or the 1921 Railroad Storm, have produced threat assessments by multiple government agencies--including some of the world's best scientists and engineers. Indeed, the Congressional EMP Commission studied the threat from a great geomagnetic storm for nearly a decade, and warned that such an event could be as catastrophic for the entire nation as a nuclear EMP attack by a high-yield thermonuclear weapon detonated at high-altitude over the geographic center of the United States. For the Congress, the judgments of Congressional Commissions are supposed to be--and historically have been-- definitive for the purposes of making public policy. With reports from the Congressional EMP Commission, NASA and the National Academy of Sciences, the previous NERC and Department of Energy Report, the FERC Report, and the UK Defence Committee Report--all these studies projecting potentially catastrophic consequences, any credible organization undertaking to minimize these concerns must subject itself, and be subjected by others, to the highest possible standards of scientific scrutiny and thorough peer review.

When NERC challenges the existing scientific consensus among all studies done by the Congress and the U.S. Government that universally conclude a great geomagnetic storm would pose an existential risk for tens of millions of Americans, the NERC assumes personal and organizational responsibilities to at least meet, if not exceed, the high technical and scientific standards of analysis and proof achieved by the Congressional EMP Commission and other U.S. Government studies. But the NERC Report does not even meet NERC's own, ordinarily less vigilant, standards of self-scrutiny and peer review, and certainly does not rise to the level of especially diligent, cautious and comprehensive data and modeling review demanded by an issue of such vital importance. Along with many other participants and members of NERC's GMD Task Force, we hope that the NERC Report will be retracted, and a suitable due diligence process review initiated to ensure that procedural and analytical problems are corrected, and an unimpeachable process put in place designed to assure the broadest possible scrutiny.

We urge the NERC Report's authors to recognize that their report, unique among all others in its optimistic assertions, could contribute to a possible failure to harden the U.S. grid against a severe geomagnetic storm. The electric grid alone is not at risk. Everything in our modern society depends, directly or indirectly, upon electricity, including all the other critical

infrastructures--communications, transportation, banking and finance, food and water--that sustain modern civilization and the lives of 300 million Americans. If a great geomagnetic storm proves to be catastrophic, as all previous U.S. Government studies have warned would be the case, the NERC could be responsible for contributing to an unprecedented national catastrophe.

What is to be done to increase our understanding of the threat to the electric grid and to advance protection of the electric grid on an accelerated basis, given the already known severity and proximity of the threat?

**Continued study of the natural EMP threat from geomagnetic storms and solutions to protect the grid should not be led by NERC.** NERC by publishing its "junk science" report deliberately crafted to mislead policymakers and the public, that grossly understates the real threat to society from severe geomagnetic storms, has impugned its own credibility for key policymakers and the public that NERC is supposed to serve. NERC has further impugned its own credibility by making personal attacks in the press on experts and groups that disagree with NERC, falsely maligning reputations and trying to damage the careers of some of our nation's best experts. Perhaps most egregiously, NERC has lost credibility by aggressively lobbying Congress to oppose legislative initiatives designed to protect the electric grid from all EMP threats, including geomagnetic storms.

NERC can no longer pretend to be an objective scientific and technical partner with the U.S. Government in assessing and protecting against threats to the electric grid when, in fact, NERC is just a lobby for the electric power industry.

**Instead of NERC, a truly objective and trustworthy actor is needed to lead continued study of threats to the electric grid, and solutions.** On my short list of nominees for this leadership role are FERC, Oak Ridge National Laboratory, NASA and the National Academy of Sciences, NORTHCOM, the Defense Science Board Task Force on EMP, or my own Task Force on National and Homeland Security--which can mobilize for this work much of the original Congressional EMP Commission.

**NERC can begin redeeming itself and make an important contribution to protecting the electric grid by collecting data from industry and providing that data for analysis by objective, independent scientists and groups.** For example, we need to know basic facts about the national fleet of EHV transformers, their numbers, locations, types, and age. We need data, known to exist, on damage to EHV transformers caused by GMD events. We need access to industry archives so objective, independent researchers can look for possible connections between GMD events and transformer damage, connections industry may be incompetent or unwilling to see.

**Continued study should not focus only on GMD, like the NERC Report, but should follow an "all hazards" strategy,** as in the 2010 FERC Report, that examined all EMP threats--natural EMP, nuclear EMP, and non-nuclear EMP from radiofrequency weapons. Indeed, the Congressional EMP Commission went even beyond this in crafting recommendations that would mitigate not only all EMP threats, but "all hazards"--including cyber attack, sabotage, and natural disasters. The EMP Commission found that there are key nodes in the electric grid and other

critical infrastructures that, if protected, would significantly mitigate all threats. The EMP Commission also found that the "all hazards" strategy, because it tends to find common solutions to all threats, is by far the most cost-effective strategy.

**Continued study and research should not become an excuse for doing nothing.** We already understand geomagnetic storms and other threats well enough, and already know that the danger to society is great enough, to warrant taking immediate action to begin protecting the electric grid now.

**Passage of the SHIELD Act (H.R. 668) is necessary to put in place the legal authorities and financial mechanisms necessary to start grid protection now.** NERC should stop lobbying against the SHIELD Act and support its passage. If NERC continues to obstruct grid protection, thereby endangering national and homeland security, NERC should be decertified in its role as a partner with FERC and the U.S. Government on matters of national and homeland security relating to the electric grid.

**Pilot projects should be launched to protect the electric power grid from geomagnetic storms, nuclear EMP, cyber attack and "all hazards" in one or more states.** From pilot projects we can learn what works best, what is most cost-effective.

Perhaps a pilot project could be launched in Alaska, the state most vulnerable to natural EMP because of its location and a likely target for nuclear EMP attack because it hosts the National Missile Defense. Under Governor Sarah Palin, when she was running for Vice President, the Alaska legislature passed, and Governor Palin signed, a Resolution calling on the U.S. Government to help Alaska protect its electric grid from natural and nuclear EMP. This Resolution from the state government and people of Alaska, calling upon Washington to help protect Alaska from natural and nuclear EMP, is appended to my testimony. The current Lieutenant Governor of Alaska, Mead Treadwell, has long supported EMP protection. Protecting the Alaska electric grid would also significantly increase the security of the lower 48 states, because the continued flow of Alaskan oil is a vital national security interest. After a natural or nuclear EMP event that paralyzes the lower 48 states, the continued flow of Alaskan oil would be especially important to support recovery of the entire nation.

New York State is another possible candidate for a pilot program to protect their electric grid. New York State is among the most vulnerable of the lower 48 states to natural EMP because of its latitude, and to nuclear EMP because of New York City. Many political leaders and concerned citizens in New York support protecting the New York electric grid from natural and nuclear EMP. Indeed, the New York State Association of Towns and Villages, representing over 1,000 Mayors and Town Supervisors, passed a Resolution petitioning the White House to protect the New York State electric grid from natural and nuclear EMP. This petition from the Mayors and people of New York State is appended to my testimony. There is even a political activist group, EMPact America, headquartered in New York, dedicated to achieving EMP protection of the New York State grid, starting with the Niagara hydroelectric facility. The Niagara hydroelectric facility is a very important node in the national electric grid that, if protected, would help recover the northeast from a natural or nuclear EMP catastrophe.

The Texas grid is another candidate for a pilot project, as there is already interest among some Texas electric utilities in achieving natural and nuclear EMP protection. Indeed, our Task Force on National and Homeland Security has received very serious inquiries from several other states that want their electric grids protected from natural and nuclear EMP--and want to proceed on their own, without waiting any longer on leadership or help from Washington.

I only wish the wisdom and enthusiasm of these states for protecting their electrical grids and their people from an EMP catastrophe could be matched by the Washington elites who are supposed to be protecting them. As FERC Commissioner Cheryl LaFleur declared at the International Electric Infrastructure Security Summit, held on April 2011 in Washington, D.C., where the topic was the threat from natural and nuclear EMP: "We have done enough studies! It is time to act!"

Returning to the primary purpose of this technical conference--analysis of the NERC Report--in summary, let me emphasize again that the NERC Report is contradicted by all previous major studies. The Congressional EMP Commission, NASA and the National Academy of Sciences, the Department of Energy, FERC, the Defence Committee of Britain's Parliament, and even a previous NERC Report--all warn that a severe geomagnetic storm could result in a protracted blackout lasting months or years, with catastrophic consequences for national survival. Even if the NERC Report's rosy assertion that a worst case geo-storm would "likely" result in a blackout lasting only hours or days is accepted as true, in any responsible, soundly engineered system, a "low-likelihood" but catastrophic threat would call for safeguards against catastrophe. If the cost of such safeguards is low, as is the case, it is inconceivable that responsible officials--government or corporate--would choose to leave the nation at catastrophic risk of even a "low-likelihood" long term grid failure.

But flaws in the NERC Report go far beyond the alarming failure to recommend hardening the grid against a geo-storm catastrophe.

The numerous prestigious studies the NERC Report seeks to overturn were developed by multiple teams of the world's best scientists, working on analysis and testing for years. To overturn these studies the scientific standards of jury-reviewed evidence, data collection, and new analysis should be extraordinarily high. Yet the NERC Report's optimistic assertions were developed in seclusion, without even the review of their own GMD Task Force participants. In fact, many participants, including from major energy companies, were surprised and disturbed by the NERC Report's rosy assertions that have been misrepresented by NERC as a consensus--when in fact the NERC Report's optimistic assertions were never proposed, reviewed, or agreed upon by all the GMD Task Force participants.

I will close with some questions for the NERC:

- 1) Why does the NERC Report embody a sudden, major change from the previous drafts?
- 2) Why was the final version of the NERC Report drafted in seclusion, without the widest possible review?
- 3) Why were pictures and data on transformer failures, present in previous drafts, removed from the final draft?

- 4) Is NERC management willing to submit to a due diligence review of the process that created the NERC Report, to be performed by an independent body?
- 5) The NERC Report refers readers to "chapters 5 and 8" to support its optimistic conclusions--but there is nothing there to substantiate that a worst-case geo-storm would result in a blackout lasting only hours or days, with no damage to transformers. What is the basis of the NERC Report's rosy conclusions?
- 6) In order to responsibly arrive at such optimistic conclusions, the NERC presumably has validated supporting data on the makeup of the U.S. transformer fleet, and accurate thermal models for most or all of the nation's transformer types. Where is the data? Where are the models?
- 7) Does NERC management judge that their report's optimistic assertions are adequately supported? Why?
- 8) What statistical analysis was done in the NERC Report to arrive at the conclusion that only power instabilities, and not long term grid collapse, would be "likely"? Does this mean that grid collapse likelihood is 20 percent, 10 percent? When will this statistical analysis be made public?
- 9) What does NERC recommend doing to protect the grid against the allegedly "unlikely"--but in the NERC Report still possible--risk of long term grid collapse? Does NERC have recommended test criteria for GIC blocking devices? If not, why not?
- 10) If the NERC Report's rosy assertions are accepted, there will be little or no effort to define rigorous standards or to implement standards for hardening transformers against geo-storms. If the NERC Report is wrong, and all the other more credible studies are right, millions of Americans could die. Does NERC management believe this is an appropriate responsibility to arrogate to themselves alone? If not, do they have a plan for a broad, independent, scientific review of their report?

Again, thank you for hearing the views of my Task Force. This concludes my testimony.