United States Senate

WASHINGTON, DC 20510

September 10, 2015

The Honorable Norman Bay
Chairman
Federal Energy Regulatory Commission
888 1st Street NE
Washington DC 20426

Dear Chairman Bay:

We are writing with grave concerns about the North American Electric Reliability Corporation (NERC) Reliability Standard TPL-007-1 for Phase 2 of Geomagnetic Disturbance (GMD) protection of the Bulk Power System. This proposed standard currently in rulemaking is vitally important, as it is intended to address the threat of widespread blackouts and transformer damage caused by solar storms (i.e., GMD events) that induce currents in long-distance transmission lines. As you review the proposed standard, we urge you to ensure that the final standard protects the grid against the sort of realistic GMD events that studies predict we may experience and ensure that credible models are used to develop the standard itself.

Solar storms hit the Earth every year, and larger storms have historically been known to cause damage to electrical infrastructure. For example, according to a 2010 report sponsored by FERC and conducted by the Oak Ridge National Laboratory[1], the 1921 Railroad Geomagnetic Storm had an intensity nearly 10 times greater than the March 1989 Hydro-Quebec Geomagnetic Storm that caused blackouts for more than a third of Canada's population for almost a day, resulting in billions of dollars in economic losses[2]. Oak Ridge National Laboratory also concluded that if a geomagnetic storm the size of the 1921 Railroad Storm occurred today, it could cause a loss of power for 130 million people in the U.S. with a recovery time of several years. In 2014, NASA[3] reported that the probability of a storm with the strength of the 1859 Carrington Geomagnetic solar storm (which Oak Ridge estimated to have a similar intensity as the 1921 storm) striking the Earth is 12% per decade, which is alarmingly high. Accordingly, the proposed NERC standard to address what could be such a devastating risk to our electric grid should receive the highest level of independent technical scrutiny by FERC staff, as well as every procedural consideration.

The NERC standard directs electric utilities to use an approved model of how GMD events affect the power grid to determine if they are required to take corrective action to protect their transmission assets. We wish to bring to your attention multiple scientific studies, including some observed data, that may illustrate weaknesses in NERC's proposed standard but have not been available for public comment on the FERC docket for this rulemaking prior to the July 27, 2015 expiration of the first comment period.

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[1] "Meta-R-319, "Geomagnetic Storms and Their Impacts on the U.S. Power Grid" http://web.ornl.gov/sci/ees/etsd/pes/pubs/ferc_Meta-R-319.pdf

[2] http://web.ornl.gov/~webworks/cpr/v823/rpt/51089.pdf

[3] http://science.nasa.gov/science-news/science-at-nasa/2014/23jul_superstorm/

Now that the Commission has established another comment period that ends on September 10, 2015, we ask that this information be included in the docket.

Recently we became aware that FERC asked a series of technical questions of Dr. Adam Schultz of Oregon State University and that Dr. Schultz answered these questions in a March 18, 2015 presentation given to FERC[4]. This presentation was subsequently made public by Dr. Schultz although it was not placed in FERC's docket for this rulemaking. Dr. Schultz's presentation highlights technical issues with the proposed NERC standard, including a summary conclusion that current one-dimensional ground models such as those used by NERC for the proposed standard may be off by "orders of magnitude." This implies that the NERC proposed standard may severely underestimate the intensity of the threat, thus yielding a reliability standard that is not protective enough of the grid.

Dr. Schultz's presentation also points out the need for additional real-world data on GMD effects on the electric grid to better understand the grid's vulnerabilities. Three-dimensional electrical conductivity data for approximately half of the continental U.S. is publicly available through the EarthScope program that is funded by the National Science Foundation. This type of data is necessary for accurate prediction of electric fields at the earth's surface, which is an essential input for accurate predictions of GMD threats to the electric grid. We urge FERC to consider mandating the use of three-dimensional conductivity models for the grid vulnerability assessments required by NERC's proposed standard.

We also have become aware that the U.S. Department of Energy has sponsored modelling of GMD effects on the U.S. Bulk Power System at Los Alamos National Laboratory. This modelling reportedly determined that the Benchmark GMD Event, which is the baseline solar storm threat against which the proposed NERC standard requires the grid to be protected, may have been set too low. Again, it is our understanding that FERC has been briefed on the results of the Los Alamos GMD model, but this report has not been placed into the FERC docket on the GMD rulemaking.

In summary, it appears that there may have been multiple GMD studies that may illustrate technical deficiencies with the NERC standard. At the same time, this critical information seems also to be missing from the FERC docket on this rulemaking. We respectfully ask that the Commission place in the FERC Docket RM15-11-000 the following written materials related to the rulemaking consideration of NERC Reliability Standard TPL-007-1, allow an opportunity for additional public comment on these materials, and ensure that these materials are appropriately considered by FERC as it further evaluates NERC's proposed regulation:

1. The briefing presented to FERC by Dr. Adam Schultz on March 18, 2015 that outlines deficiencies in the ground model of the NERC standard entitled, "Briefing on GMD/GIC Considering 3-D Crust and Mantle Conductivity Structure with Real-World Complexity."

2. The Los Alamos National Laboratory study sponsored by the Department of Energy and presented to FERC that outlines potential deficiencies in NERC Standard TPL-007-1.

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[4] "Briefing on GMD/GIC Considering 3-D Crust and Mantle Conductivity Structure with Real-World Complexity" https://www.dropbox.com/s/p6o6s6f3tj87tnl/Schultz-FERC-Briefing-March-2015.pdf?dl=0

3. A white paper referenced in Dr. Schultz's presentation entitled, "Examination of NERC GMD Standards and Validation of Ground Models and Geo-Electric Fields Proposed in this NERC GMD Standard,"[5] authored by John Kappenman of Storm Analysis Consultants, and Dr. William Radasky of Metatech Corporation, that shows measured and predicted ground induced current data at various locations in the U.S.

We also have questions about the scientific assumptions used to justify NERC's proposed standard. We strongly urge you to re-evaluate the underpinning analyses as well as the additional materials referenced above. Please answer the following questions regarding the proposed rulemaking:

1) Does FERC monitor the effects of GMD events on electric grid outages and reliability at large, and is this information publicly available, much as the effects of other natural disasters such as hurricanes and earthquakes would be publicly available? If so, where can this information be accessed, and if not, why not?

2) Does FERC agree that the electric grid in the U.S. is currently not protected against solar storms the magnitude of the 1921 Railroad Storm or 1859 Carrington Storm, and that if a storm of equal or greater magnitude occurred today, cascading blackouts and transformer damage would likely occur across the entire U.S.? If not, please explain why not.

3) Regarding the Benchmark GMD Event in NERC's proposed standard:

   a. Does FERC agree that the Benchmark GMD Event actually represents a low-level solar storm threat?
   b. Does FERC agree that the solar storms that hit the Earth in 1859 and in 1921 were more intense than NERC's Benchmark GMD Event?
   c. Does FERC have an estimate of the frequency of the solar storms that result in a GMD event on the scale of the Benchmark GMD Event in this proposed rulemaking? If so, please provide details.
   d. Does FERC have any documentation from the scientific community that demonstrates that the Benchmark GMD Event set by NERC in this proposed rulemaking is a reasonable benchmark? If so, please provide it.
   e. Are utilities exempt in the proposed rulemaking from paying for damages to the electric grid caused by GMD events larger than the Benchmark GMD Event? If so, would it be your expectation that these costs would be borne by consumers?

4) The deleterious effects of a solar storm are dependent upon location because the geologic structure of the land impacts the geomagnetically induced current (GIC), which is what harms the grid. There is GIC and magnetometer data for the U.S. that could have been used to develop and validate the Benchmark GMD Event. The NERC description[6] of its derivation of the Benchmark

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[5] http://www.nerc.com/pa/Stand/Project201303GeomagneticDisturbanceMitigation/WhitePaper_NERC_Model_Validation_07302014.pdf

[6] http://www.nerc.com/pa/Stand/Project201303GeomagneticDisturbanceMitigation/Benchmark_GMD_Event_Dec5_clean.pdf

GMD Event states that the real-world data used in the analysis was collected from IMAGE stations located in Northern Europe, and not from data sources in the U.S. It is not valid to use geomagnetic field data from other locations on the earth in order to model GMD in the U.S. unless a simplified model is used that assumes no "strong [electrical] conductivity anomalies,"[7] (i.e., abrupt changes in the ground conductivity). Dr. Schultz's research[4] shows that there are in fact abrupt changes in electrical conductivity in his 3-D model of the U.S. geological structure in many regions, including the Pacific Northwest and the upper Midwest. Therefore, NERC's use of European magnetometer data would likely result in inaccurate modeling of the U.S. grid vulnerability, which could in turn result in less aggressive corrective action requirements. Does FERC agree that NERC's use of European magnetometer data and a simplified ground conductivity model would yield inaccurate results? If not, why not? If so, will FERC require NERC to re-do its modeling of the Benchmark GMD Event using U.S. data?

5) In the NERC-proposed standard, the electric grid reliability is quantified by a measure called the "Geomagnetically Induced Current withstanding rating," and the standard proposes a safe rating of 75 amps per phase during a Benchmark GMD Event. This rating would be used to identify which transformers would require additional hardware protection. Can FERC demonstrate that a rating of 75 amps per phase is a safe upper limit using real-world data collected from the U.S. electric grid?

6) For regions of the grid that fail NERC's proposed grid vulnerability assessment (i.e., GIC withstanding rating equal or greater to 75 amps per phase), the NERC proposed standard requires a Corrective Action Plan be submitted to FERC. However, it appears that there is no timeline for the mandatory completion of any needed corrective actions. Is this accurate? If so, will FERC require the mandatory completion of needed corrective actions in any final regulations?

7) Does FERC have an estimate of the number of transformers that would require hardware protection as a result of this proposed rulemaking? If so, please provide that estimate along with the size or rating of the transformers.

8) The white paper referenced in Dr. Schultz's presentation entitled, "Examination of NERC GMD Standards and Validation of Ground Models and Geo-Electric Fields Proposed in this NERC GMD Standard," shows differences between measured and predicted GIC data at the Tillamook Oregon substation. The predicted GIC data was generated using the NERC model that uses a one-dimensional GIC model. During peak GIC occurrences, the predicted GIC based on the NERC model varied more than 700% from the measured data. Does FERC believe that this apparent level of inaccuracy in the models used by NERC is acceptable for a critical reliability standard?

Additionally, in an effort to understand FERC's activities on this proposed rulemaking, we also request a calendar list of meetings not listed in the docket that have been held on the topic of this rulemaking among FERC Commissioners, FERC staff, and outside parties such as NERC, industry

[7] http://www.earth-planets-space.com/content/67/1/93

representatives, and the public. In this listing, we request a list of the attendees, discussion topics, and presented materials.

Thank you for your consideration of this important request. We ask that this letter be placed in the FERC Docket RM15-11-000, Reliability Standard for Transmission System Planned Performance for Geomagnetic Disturbance Events. Please provide a response by close of business on October 1, 2015. If you have questions or concerns, please contact Briana Tomboulian or Michal Freedhoff at 202-224-2742.

Sincerely,

Edward J. Markey
United States Senator

Cory A. Booker
United States Senator