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March 15, 2019

The Honorable Ron Johnson
Chair
Homeland Security and Governmental Affairs Committee
United States Senate
Washington, D. C. 20510

Dear Mr. Chairman,

Thank you for inviting me to appear before your Committee on February 27, 2019, at the roundtable session on EMP and GMD issues. These are such important issues and ones Dominion Energy has been diligently working to address.

At the roundtable, you asked me and the other participants to review carefully statements made by Dr. George H. Baker and to submit written comments regarding his recommendations. My responses are attached for your review.

I also want to thank your staff who have been very helpful during this entire process. I will be happy to discuss any of these issues further should you require additional information.

Sincerely,

David W. Roop, P.E.
Director – Electric Transmission Operations & Reliability

Dominion Energy Response to

Testimony of Dr. George H. Baker, Professor Emeritus, James Madison University

To Committee on Homeland Security and Governmental Affairs

U.S. Senate

February 27, 2019

Submitted by David W. Roop, P.E.

Director – Electric Transmission Operations & Reliability

Dominion Energy

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As requested by the Committee, Dominion Energy submits these comments on the testimony of Dr. George H. Baker, Professor Emeritus – James Madison University and Director – Foundation for Resilient Studies, presented to the Committee on February 27, 2019. Dominion Energy appreciates the opportunity to comment on Dr. Baker's testimony and recommendation.

We commend Dr. Baker on his many contributions to the citizens of the United States through his efforts to protect U.S. military facilities from the effects of electromagnetic pulse (EMP). His efforts to develop and implement methods to protect this vital infrastructure are very much appreciated. However, these comments regarding his testimony are intended to provide clarity to EMP's relation to the electric power industry, since Dr. Baker's considerable expertise in this field lies outside the electric industry.

Our nation's electrical system is one of the most complex machines ever developed by man. It has been built by many years of experience and by sound engineering disciplines. The transmission system constantly changes every millisecond, balancing to provide the reliability that we have all come to expect in this country. The protection and control systems must sense events that may cause harm to this network, and to the general public, and isolate the event to the smallest area possible within cycles (1 cycle = $1/60^{th}$ of a second) of the disturbance's initiation. Events must be cleared rapidly to ensure the overall system remains stable and affected areas are kept to a minimum.

The ever-changing state of this complex system requires our Operating Centers to constantly analyze contingencies (i.e. "what-if" scenarios) and take pre-contingency actions if the real-time data suggest something has or could create a vulnerability. This local understanding of load, generation, grid topology, and real-time contingency analysis is critically important. It ensures

reliable operations and is also needed should restoration efforts, including blackstart efforts, be required. We have taken this same approach regarding geomagnetic disturbance (GMD) events. Our Operating Centers' tools provide situational awareness and actions to operators during GMD-related events. This capability was made possible through collaborative research conducted with the U.S. government and other entities.

These facts are important as we review Dr. Baker's testimony. It is important to understand how our system operates before we modify it so that we do not cause harm or potential negative consequences during the daily events that occur on the power grid. With that fundamental principle in mind, we offer the following comments on specific statements in Dr. Baker's testimony (highlighted below).

Dr. Baker's Statement*: "The FERC GMD Standard (TPL-007-2), though its specified environments and system thresholds are not defense-conservative, has at least brought industry attention to GMD effects. This standard, even if rigorously enforced will leave the grid dangerously vulnerable to GMD and needs to be revised."*

Comment: We respectfully disagree with Dr. Baker's statements regarding the standard. The NERC TPL-007-1 Reliability standard included a 100-year GMD benchmark case based on statistical analysis of historical GMD events and 30 years of observational data. Furthermore, the TPL-007-2 standard included a supplemental benchmark case which has considered local enhancement phenomena during a solar storm. It is worth emphasizing that the study of solar storms and local enhancement phenomena is an evolving science. The peak values of the storm are scientifically derived based on credible measurement data and information using statistical methods with 95% likelihood. The conclusion is comprehensive and trustful. The

TPL-007 standard therefore provides extremely sound guidelines for planning and reliability assessment. Additionally, the standards consider a wide-area power system, not a small subset area. The peak values provided in the benchmark case are geospatially averaged values with a distance span of 100 kilometers. Due to irregular earth conductivity characteristics, it is possible that local geo-electric field measurements would be higher than the average peak, with the latter representing the statistical maximum of a one-hundred-year event on a large distance scale.

Dr. Baker's Statement: ***"Without corresponding FERC EMP directive, the private sector is not doing very much of anything to address the EMP threat. An EMP directive and protection standard is sorely needed."***

Comment: The electric power industry is doing all it can reasonably do to protect itself and its customers from EMP, given our limited knowledge of the impact of potential EMP threats on equipment or systems. Our efforts in this area are not publicized for obvious reasons: we do not want to provide someone with information that could be used to thwart our defenses.

However, we are taking action. In many cases these actions can be classified as "no regrets hardening" which also improves overall day-to-day operations. ("No regrets hardening" include measures such as metal control enclosures, continuously shielded protection and control cable, etc.).

While Dominion Energy and multiple utilities across the U.S. have taken this approach, we know more needs to be done after adequate research, testing, and study to ensure the measures do not severely disrupt vital day-to-day operations. As discussed during oral testimony presented to the Committee, the research activities taken thus far, with significant assistance from our federal partners, have provided much-needed guidance to reduce the vulnerability of our equipment to

damage or disturbance during an EMP event, while at the same time ensuring that the mitigation and hardening steps identified and installed do not cause harm or disruption to daily grid operations and existing grid equipment. The research is not complete; further research is needed before we can take the final steps to harden our systems. But doing something without sufficient guidance would not be prudent and would place undue burden on utilities with little benefit for our customers. It would also add to the possibility of significant risk, damage, and harm to daily grid operations and grid equipment.

Dr. Baker's Statement: ***"New legislation is needed to empower FERC, specifically to***

(1) Enable FERC to write and enforce grid protection standards.

Comment: Great care should be taken in efforts to develop a "one size fits all" standard. Electric systems were built across the nation over many decades with varying voltages, configurations and designs, as operating experiences and conditions dictated. Input is needed from the various stakeholders due to the complexity and variances across the U.S. in the design of the bulk power system. NERC has a thorough process to do this as is evidenced by their cyber protection work and other electric grid standards.

For many issues, the stakeholder process has helped us improve and enhance this system. These challenges are no different. They warrant a similar approach. I submit that this does add time to this process but the negative impact potential warrants careful deliberation. If FERC becomes aware of a potential resiliency issue(s), then FERC should have the authority to confidentially provide guidance regarding the threat and authorize the financial recovery required for utilities to resolve the vulnerability, without public disclosure of the issues that would compromise national security or reveal the resiliency issue.

(2) Identify mechanisms, including cost recovery measures, to incentivize private sector engagement on EMP protection and increase on-site fuel stockpiles.

Comment: Once ongoing research establishes an understanding of the minimum requirements for action, then a cost recovery or incentive mechanism would be beneficial to ensure rapid deployment. The impact of EMP on renewable generation resources, such as solar facilities, is only one of the areas that should be the focus of research. We must note, however, that as we move more and more towards heavy penetration of renewable generation, our need for on-site fuel supplies will continue to diminish, due in large part to the closure of coal-burning facilities.

(3) ***Develop a national blackstart plan****."*

Comment: Blackstart must be done regionally due to the complexity of the load/ generation balance and the understanding of the state of the electric network prior to the black out. (This knowledge is built on the "what-if" scenarios previously discussed and cannot be replicated in a national plan.) It is important to note that blackstart is NOT starting the system by leaning on a neighboring utility. Rather, the transmission owner must restart its own grid using its own equipment, with no help from any neighboring utilities. This is the definition of blackstart restoration for Transmission Owners and Operators, and all have in place blackstart plans, strategies, and equipment. There has never been a true blackstart event in the continental U.S. but all transmission owners must be prepared to restart their own system should this occur. Once one utility is restarted it will aid its neighboring utilities. This already happens with major restoration efforts. A national blackstart plan would provide no benefits except to emphasize federal priorities; however, those priorities are currently being provided by the Department of Homeland Security (DHS).

Dr. Baker's Statement: "A national EMP protection standard is needed. DHS is to be commended for issuing a coordination version of a communication / data center protection guidelines. DHS should expand this to include HV electric generator stations and electric substations."

Comment: As noted above, it is highly problematic to develop and implement a standard without a thorough understanding of its impact on daily operations. The industry still has open questions regarding the most cost effective way to protect digital equipment from an EMP (E1) conductively coupled waveform. Currently available solutions may be hard to install and worse yet, could cause significant unintended consequences during daily grid events.

The lessons learned from our transmission research can also be readily applied to our generation assets. For example, the use of MIL spec standards is not only cost prohibitive but can reduce the speed of operations of some equipment, which could create wide-area events and outages during normal grid operations.

As noted in my testimony, productive work can be done by the U.S. government such as:

- Testing of vehicles to make sure they will work if exposed to an EMP event so that we can be assured that response will not be impaired.
- Testing of distribution insulators to provide guidance as to good, better, and best voltage classifications. This would allow the industry to begin installing the correct voltage class insulators to mitigate the EMP waveform effects seen in the 1962 Starfish Prime nuclear testing or in the Russian atmospheric nuclear tests.
- Providing guidance to the industry on leveraging the hardened Federal Emergency Alert System to respond to EMP and other large-scale events. The system could provide

notification to our personnel that the outage they are experiencing is not a “normal” outage, but rather an EMP or other large scale event requiring that they report to their preassigned work locations.

- Testing of an *E1 EMP Surge device.* This will occur in 2019 and may demonstrate that there is not currently an available adequate product on the market. This may require engagement and research by the DOE and the National Labs to develop such a product.
- Further research and guidance for developers of renewable generation, as they become more predominant, on what is required to harden these assets to EMP.
- Assessment of the potential extent of damage to microgrid installations that are not in-service but react only after an EMP event. This would help resolve the question of whether full EMP hardening is needed in the case of not-in-service (i.e. not energized) equipment.
- Development of a national communication system that is robust enough to support restoration and response efforts during an EMP event. The utility industry is currently working to pilot a system to determine functionality and the cost to deploy.

Dr. Baker’s Statement: “For more than half a century, DoD has protected high priority military command, control, communication, and computer assets for nuclear deterrence and response. DHS and DOE EMP/GMD protection programs should emulate DoD’s efforts.”

Comment*:* As noted by Dr. Randy Horton of EPRI, the use of MIL Spec standards creates issues for daily transmission system operations; we cannot use MIL Spec without negatively impacting normal grid operations. Although the Mil Spec standard is needed to protect DOD facilities, for the electric industry, the cost of using the standard is not justified if we can develop

alternative ways to effectively reduce the impact on operations without going to this extreme. The U.S. electric system has built-in redundancy, so the loss of some components does not necessarily lead to a widespread, unrecoverable blackout. However, MIL Spec designs are prudent for new primary Operating Control Centers and many utilities are moving in this direction, as has Dominion Energy, without a regulatory requirement.

Dr. Baker's Statement: "We must preclude the temptation to re-invent the wheel by giving DHS and DOE full access to DoD standards and data bases. There is no need to recalculate a standard EMP waveform. Note that current EPRI grid vulnerability assessment models are using low-bound recalculated E3 waveforms. Existing IEC and EMPC EMP waveforms are more than adequate. Use of unclassified MIL_STD_188-125 test regimen will assure power grid survivability to both EMP and 100-year solar storms."

Comment: The guidance from the federal government is very much appreciated but we also understand the national sensitivity with some of their data. Regarding the Mil Spec standard, we believe it is an excellent standard for primary control centers of our electric grids, but, as previously noted, is not suitable for other protective measures, notably substation control enclosures.

The electric grid is extremely important to this nation's vitality. Whatever we do with regard to EMP cannot impact this system's daily function. As stated, additional research is needed before we can offer industry-wide guidance on the best approach to mitigate these threats while not negatively impacting daily grid operations.

We acknowledged that GMD and EMP (E3) waveforms are significantly different in duration; thus their impact on electrical equipment is very much different. The GMD waveform can last

from hours to days with several peaks during this period where the EMP (E3) event will be of a very short duration. However, the efforts underway to harden equipment for GMD should provide improved protection for the short EMP (E3) event.

Our industry is committed to serving our customers and making prudent investments. I can assure this Committee that many in our industry are working hard in both of these areas with the knowledge that we have today. We recognize the risk, but work is still needed if we are to harden our systems in a manner that is reasonable and justified.

On behalf of Dominion Energy, I greatly appreciate the opportunity to testify on this topic and comment on Dr. Baker's work and concerns. I hope this information will be helpful in your deliberations.