

**Testimony of Cheryl LaFleur**  
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**Before the Committee on Energy and Natural Resources**  
**United States Senate**  
**May 4, 2017**

Chairman Murkowski, Ranking Member Cantwell, and Members of the Committee:

Thank you for the opportunity to appear before you today to discuss electromagnetic pulse (EMP) threats to the electric grid in the United States. I appreciate the Committee's attention to this important issue.

The Federal Energy Regulatory Commission (FERC) plays a central role in protecting the reliability of the Nation's electric grid against a range of threats, both naturally-occurring and manmade. Our work generally takes the form of both mandatory reliability standards and voluntary, collaborative efforts with our federal and state colleagues, industry, and other stakeholders. Before turning to EMP specifically, I would like to provide an overview of the evolution of FERC's reliability work, which I believe will help inform that discussion.

**FERC's Oversight of Grid Reliability**

In the Energy Policy Act of 2005, Congress entrusted FERC with a new responsibility to approve and enforce mandatory reliability standards for the Nation's bulk-power system. This authority is found in section 215 of the Federal Power Act (FPA), and is limited to the "bulk-power system," as defined in the statute, which excludes Alaska and Hawaii, as well as local distribution systems.

Under FPA section 215, FERC cannot directly write or modify reliability standards but must rely on the Electric Reliability Organization (ERO) that FERC certifies to perform this task. In 2006, FERC certified the North American Electric Reliability Corporation (NERC) as the ERO. Under the section 215 construct, NERC develops and proposes for FERC's review new or modified reliability standards. In addition, as I will discuss in more detail below, FERC may direct NERC to develop or modify a standard and has done so when FERC determines that new or modified standards are needed. Once NERC develops a standard, it is filed with FERC, at which time FERC can either approve or remand the standard. If FERC approves a proposed standard, it becomes mandatory and enforceable in the continental United States and is applicable to the users, owners and operators of the bulk-power system. If FERC remands a proposed reliability standard, it is sent back to NERC for further consideration.

In addition to its formal standards work, FERC has also supported grid security through voluntary and collaborative efforts. Largely conducted by FERC's Office of Energy Infrastructure Security, FERC has worked closely with other federal agencies, states, industry, and other stakeholders to improve coordination and knowledge-sharing regarding threats to the grid. This work includes, among other activities, the development, identification, and dissemination of best practices; participation in grid reliability exercises; and providing briefings to state colleagues.

FERC, NERC, and industry have made significant progress over the last decade to put in place a robust set of baseline standards to address basic day-to-day grid reliability issues, like tree trimming and relay setting. Reaching a steady state on those standards has allowed us to increasingly shift our attention to cutting edge or emerging threats, like cyber and physical security of critical grid infrastructure, and the risks associated with geomagnetic disturbances (GMD) from solar storms and EMP attacks. Going forward, I expect that our collective attention to these issues and the risks posed by high-impact, low-frequency events will only increase. Later in my testimony I will explain some of the work we have done to date on these issues and how it helps to provide protection against potential EMP threats.

### **EMP Threats**

I will now turn to EMP, as well as a related discussion about the threats posed by GMD. The bulk-power system may be impacted by electromagnetic events, such as naturally-occurring GMD or man-made EMP. In the case of EMPs, equipment is available that can generate localized high-energy bursts designed to disrupt, damage or destroy electronics such as those found in control systems on the electric grid. EMPs can be generated by devices that range from small, portable, easily concealed battery-powered units all the way through missiles equipped with nuclear warheads. As described, for example, in a recent report from the Los Alamos National Laboratory, depending on the yield of the device and the altitude of its detonation, EMP devices can generate three distinct effects of varying magnitude, each impacting different types of equipment: a short, high energy Radio Frequency-type burst called E1 that can destroy electronics; a slightly longer burst that is similar to lightning, termed E2; and a final effect, termed E3, that generates electric currents in power lines and equipment, which can then damage or destroy equipment such as transformers.

In the case of GMDs, naturally occurring solar magnetic disturbances periodically disrupt the earth's magnetic field, which, in turn, can induce currents on the electric grid that may simultaneously damage or destroy key transformers over a large geographic area. GMD events are similar in character and effect to the final phase of EMP, termed E3, as they can affect the same equipment including transformers. Any of these effects has the potential to cause voltage problems and instability on the electric grid, which could lead to wide-area blackouts.

The risks posed by EMP and GMD events have been the subject of significant scientific research and debate, as well as broad discussion among regulators, elected officials, industry, and other stakeholders about the appropriate steps to address these threats. FERC has been actively involved in these discussions, and the threats posed to the grid by electromagnetic events, particularly GMD, have been a particular priority of mine during my time at FERC. While the threats posed by GMD and EMP overlap in part, our understanding of those threats and how to effectively mitigate them has led to different approaches to address them.

With these issues and challenges in mind, FERC has used both regulatory and more informal collaborative approaches to address EMP threats.

### **FERC Regulatory Actions**

First, with respect to regulatory actions, FERC has acted through both its reliability authority under FPA section 215 and its ratemaking authority under FPA section 205 to support grid reliability efforts that help protect against EMP threats.

Through its work on GMD, FERC has taken steps that help to mitigate one aspect of EMPs, i.e., the effect of the E3 component on high-voltage transformers and other equipment. In 2013, FERC directed NERC to develop GMD reliability standards in a two-stage process. The first stage GMD reliability standard, which has been in effect since 2015, requires responsible entities to develop and implement operational procedures to mitigate the effects of GMDs. The second stage GMD reliability standard, which FERC approved in 2016, requires responsible entities to conduct initial and on-going assessments of the potential impact of a benchmark GMD event on bulk-power system equipment and the bulk-power system as a whole and to mitigate any assessed vulnerabilities. With respect to the second stage GMD reliability standard, FERC also directed NERC to develop modifications and perform additional GMD research on specific issues to ensure that the protections against GMD evolve with our improving understanding of the science.

FERC has also taken other actions that provide a measure of protection against EMP threats, particularly through its efforts to protect the grid against physical threats. The nature of physical attacks – which, like EMP events, are intentional, manmade efforts to disrupt the electric grid – introduce additional complexities not present in events that have caused wide-spread blackouts and reliability failures in the past, such as vegetation-related events. Recognizing these risks, in 2014, FERC directed NERC to develop a reliability standard that addresses physical security threats. FERC approved NERC’s proposed physical security reliability standard later that year. The physical security reliability standard requires responsible entities to

mitigate assessed vulnerabilities to critical transmission facilities through resiliency or security measures designed collectively to deter, detect, delay, assess, communicate, and respond to potential physical threats and vulnerabilities. This standard, insofar as responsible entities harden their substations and improve perimeter security to address their assessed vulnerabilities, can help address the use of small, portable EMP devices that require close proximity to their intended targets.

FERC, NERC, and industry have also dedicated significant attention to improving grid resilience. Resilience efforts cover a range of actions that grid owners and operators can take to reduce the risks associated with the loss of individual or multiple assets and to improve recovery and restoration following such losses. FERC has supported efforts to improve the design, planning, maintenance, and operation of the grid through its standards and rate work, as well as through collaborative efforts. For example, some of these efforts stem from requirements in mandatory reliability standards to ensure backup capabilities for the loss of critical assets, or to de-risk critical assets, which reduces the potential for cascading outages.

One important element of grid resilience is ensuring adequate inventories of critical grid infrastructure, particularly long-lead time construction items like high-voltage transformers. Through its rate-making authority, FERC has issued orders to provide clarity on how it will address services provided by Grid Assurance, a company created by several electric utilities and energy companies, and Edison Electric Institute's (EEI) STEP program. Over the last two years, FERC issued orders addressing important cost recovery and rate design questions concerning Grid Assurance's service model, which is intended to support transmission owners in the procurement, maintenance, and delivery of transformers and related equipment in the event of a loss of a critical transformer. Similarly, EEI's STEP program, which FERC approved in 2006, provides a sharing service for backup or spare transformers among participating transmission owners. These programs are intended to enhance grid resilience and protect customers from prolonged outages by providing electric utilities with timely access to emergency spare transmission equipment that otherwise can take months or longer to acquire.

As noted above, the GMD and physical security standards help provide protection against particular aspects of the EMP threat. However, FERC has not directed NERC to develop a standard specifically targeting EMP. To be clear, I believe this is the result of reasoned consideration of the issue. FERC has repeatedly demonstrated a willingness to direct NERC to develop or modify a reliability standard where FERC identifies a gap in the protection of the bulk-power system; indeed, the physical security and GMD standards, as well as an ongoing effort to develop a standard to address supply chain threats, were the result of FERC directives. It is also worth noting that directives to develop new standards have been supported by FERC commissioners from both parties, demonstrating a strong bipartisan commitment to

grid reliability.

I recognize that some parties have challenged FERC's decision to proceed with a GMD standard that did not also include EMP threats more generally. I believe that FERC's approach has been prudent, given our understanding of those threats and potential mitigation to address them. With GMD, FERC was able to identify and direct a structured plan of monitoring, assessment, and mitigation that targets specific critical grid components (e.g., high voltage transformers) for protection against a GMD event. That plan was the result of years of FERC, NERC, and industry efforts to understand the GMD threat and determine how best to protect against it.

By comparison, large-scale EMP attacks pose a very different threat to the grid, and one that, to date, FERC has not determined is well-suited to a mandatory reliability standard at this time. Although much work has been done, there remains a significant amount of scientific research and debate underway about EMP threats. For example, in January 2017, DOE, in its role as the Sector-Specific Agency for the Energy Sector, issued its Electromagnetic Pulse Resilience Action Plan, which lays out a multi-year effort to improve our understanding of EMP threats, effects, and impacts; identify priority infrastructure; test and promote mitigation and protection approaches; enhance response and recovery capabilities; and share best practices. DOE, through the Los Alamos National Laboratory, is working with the Department of Homeland Security (DHS) to advance our understanding of EMP's effects on the electric power system. DOE's Idaho National Laboratory is also working to develop potential EMP strategies, protections, and mitigation for the electric grid. Similarly, the Electric Power Research Institute is currently conducting a multi-stage study of grid impacts associated with EMP threats, including evaluations of the impacts of E-1, E-2, and E-3 components.

In addition, last year, Congress directed DHS to conduct research and development on how to mitigate the consequences of threats of EMP and GMD, and report periodically over several years. A year earlier, Congress also re-authorized the EMP Commission, initially created in 2001, to continue to assess and report on the threats posed by EMP.

EMP threats present unique challenges as well. Unlike naturally-occurring GMD, which can be measured and subject to rigorous public scientific debate, EMP threats stem from hostile actors, particularly foreign nations, which introduces complexities regarding confidential national security information that are not readily adapted to FERC proceedings or the NERC standards development process. Any standard we may adopt in the future may need to differ from our usual standards, in order to avoid the security risk of announcing publicly the limits of our protective mitigation.

Furthermore, while there has been much written regarding the nature of the threat from EMP, consensus has not been reached regarding how best to protect against it. While the military has developed protocols to protect key assets, these protocols have been described by Los Alamos National Laboratory as “not widely implemented in civilian applications due to the expense,” and by Idaho National Laboratory as “focused on load center protection for communication stations, control and mission critical facilities, not distribution, transmission and large generation assets for the electric power grid.” Given the scope and potential cost of an effort to protect the entire grid against an EMP attack, I think it is prudent that FERC not launch a mandatory standard unless it concludes that the standard would effectively mitigate the threat at a justifiable cost. Ongoing research by DHS, DOE, and others eventually may support such a conclusion, but to date, FERC has not reached that conclusion.

That said, as described below, FERC remains actively engaged in efforts to understand and address the EMP threat. Those efforts will continue, and I am confident that, should FERC ultimately determine that a reliability standard is warranted, it will exercise its authority under FPA section 215 to require one.

### **Collaborative Efforts**

FERC is also actively involved in efforts beyond its standards process. As noted above, FERC works closely with Federal agencies, state partners, and industry to identify key energy facilities; provide threat briefings, including on GMD and EMP threats; assist with the development and identification of best practices for mitigation; and cooperate with international partners to convey threat and mitigation information, as well as encourage adoption of best practices for mitigation. DOE, DHS, and the Department of Defense (DOD) have been particularly active on EMP issues, with DOE engaging the national labs to help support its efforts. In this regard, in 2015 I had the opportunity to visit the Idaho National Laboratory for a couple of days to learn about its work on cybersecurity and GMD issues.

Many of FERC’s collaborative actions involve cross-sector, interagency, and public-private efforts to improve our collective understanding of GMD and EMP threats. For example, FERC participates in DOE’s Electric Sector Coordinating Council, which is evaluating both EMP and GMD threats. In 2010 FERC, DHS, and DOE released a report conducted by the Oak Ridge National Laboratory that investigated and identified the effects of, and mitigation measures for, both GMD and EMP on the Nation’s power grid. FERC is an active participant with the Energy Infrastructure Security Council, assisting with national and international collaboration. These efforts include the publication of resources in collaboration with DOE and participation in state and national table-top exercises simulating EMP attacks and coordinated responses as well as potential proactive protection measures.

FERC continues to monitor international efforts to address EMP and GMD, including collaborating on both foundational and best practices. In 2016, FERC exchanged information with Norway and expects to do so with both the UK and Israel later this year. On a national level, FERC briefed the EMP Commission earlier this year and has offered further collaboration to DHS, DOE, DOD, the national laboratories, and industry.

In addition, in November 2014, the National Science and Technology Council created the Space Weather Operations, Research, and Mitigation (SWORM) Task Force to develop high-level strategic goals for enhancing national preparedness for a severe space weather event. The SWORM Task Force is co-chaired by members from the Office of Science and Technology Policy, DHS, and the National Oceanic and Atmospheric Administration. FERC has participated in the SWORM Task Force's efforts from its inception. As a result of this work, FERC was an active participant with the development and release of both the National Space Weather Strategy and the National Space Weather Action Plan. FERC also assisted with the follow-up Executive Order released in October 2016 that, among other things, directed DOE and DHS to "develop a plan to test and evaluate available devices that mitigate the effects of geomagnetic disturbances on the electrical power grid through the development of a pilot program that deploys such devices." FERC has offered further assistance to DOE should this work proceed.

Most recently, FERC has assisted both DOE and DOD to identify defense-related critical electric infrastructure as directed under the FAST Act, thereby assisting with their decisions regarding EMP and GMD protection at these facilities. Further, in response to a directive of the FAST Act, DOE, after consulting with FERC and others, submitted a Strategic Transformer Reserve report to Congress in March 2017. This report described the importance of maintaining a strategic transformer reserve, as well as the current efforts underway by the industry and government to mitigate potential threats to the U.S. bulk-power system created by the vulnerabilities of these transformers. Specific to the subject of today's hearing, these threats include both EMP and GMD events. DOE recommends encouraging and supporting an industry strategic transformer reserve driven by voluntary industry actions and NERC's physical security reliability standard's requirements. DOE also recommends that it re-assess this approach in the future with FERC and electricity industry partners to determine whether sufficient progress has been made through this approach or if alternative actions by the government might be necessary. As noted above, FERC has encouraged these efforts through its collaborative outreach and ratemaking authority.

Thank you again for the opportunity to testify today. I would be happy to answer any questions you may have.