OVERSIGHT OF FEDERAL EFFORTS TO ADDRESS ELECTROMAGNETIC RISKS

HEARING

BEFORE THE

SUBCOMMITTEE ON OVERSIGHT AND MANAGEMENT EFFICIENCY

OF THE

COMMITTEE ON HOMELAND SECURITY HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTEENTH CONGRESS

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OVERSIGHT OF FEDERAL EFFORTS TO ADDRESS ELECTROMAGNETIC RISKS

Tuesday, May 17, 2016

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON HOMELAND SECURITY,
SUBCOMMITTEE ON OVERSIGHT AND
MANAGEMENT EFFICIENCY,
Washington, DC.

The subcommittee met, pursuant to call, at 10:07 a.m., in Room 311, Cannon House Office Building, Hon. Scott Perry [Chairman of the subcommittee] presiding.

Present: Representatives Perry, Duncan, Clawson, Carter, Loudermilk, Watson Coleman, and Torres.

Also present: Representative Franks.

Mr. PERRY. The Committee on Homeland Security Subcommittee on Oversight and Management Efficiency will come to order.

The purpose of this hearing is to receive testimony regarding the Federal Government's efforts to address risks associated with electromagnetic pulse, or EMP, events.

The Chair asks unanimous consent to allow the gentleman from Arizona, Mr. Franks, the opportunity to participate in today's hearing.

Without objection, so ordered.

The Chair now recognizes himself for an opening statement.

America's energy infrastructure is the heart that pumps the American economy. Long-term power outages resulting from an attack on our critical infrastructure could cripple our Nation's economy and put America's health and safety in jeopardy. Because the Nation's critical infrastructure is so vital to America's way of life, the Federal Government has recognized the necessity of securing our infrastructure from an array of risks, including the threat of EMP, electromagnetic pulse, attack.

The most serious EMP risk would come in the form of an EMP resulting from a nuclear detonation at high altitude. Such an attack could cause long-term damage to the power grid. While many believe the likelihood of such an attack is low, the damage and economic aftershocks that would follow demand that we address these risks. We cannot discount that other nation-states, such as North Korea, or sophisticated terror groups might want to utilized EMP to wreak havoc on our economy.

The Departments of Homeland Security and Energy and the Federal Energy Regulatory Commission have an active role in protecting our critical infrastructure. According to a GAO, Government Accountability Office, report released last month, Federal agencies

have taken action—it is important to note—have taken action to prepare and mitigate EMP risks, but there is still room for improvement, as always.

According to GAO, DHS and Department of Energy have addressed some but not all of the recommendations in a 2008 report from the Congressionally-authorized EMP Commission. Unfortunately, DHS has yet to clearly identify a lead office or official within the Department to coordinate efforts internally and with other Federal and industry stakeholders. How can DHS protect us against EMP risks if they don't know who is in charge? I expect to hear from DHS's witness today on how the Department has corrected this failure.

GAO has also found that Federal partners must do a better job of collaborating their planning activities. Additionally, GAO made recommendations to improve how DHS analyzes EMP risks and how DHS and DOE identify and implement key research and development priorities.

Overall, GAO found that the Federal Government's efforts to prepare for and mitigate EMP risks are at best a mixed bag. The progress made to date is certainly due in part to Congress' oversight efforts and the recommendations made in 2008 by the EMP Commission. DHS and DOE must make more headway in their efforts to address EMP. Effectively engaging the private sector to assist with planning and building system resiliency will be an essential component of these efforts.

Congress must also do its part. In November 2015, the House passed H.R. 1073, the Critical Infrastructure Protection Act, authorized by Congressman Trent Franks of Arizona, which would require better planning research and development for EMP risks. Unfortunately, like many other bills passed by this committee, it remains stuck in the Senate.

I certainly appreciate the hard work of our watchdogs at GAO for their report and the witnesses for appearing before this subcommittee today. I look forward to hearing how Federal agencies will work to improve themselves in light of GAO's findings to better protect the American people from EMP risks.

[The statement of Chairman Perry follows:]

STATEMENT OF CHAIRMAN SCOTT PERRY

MAY 17, 2016

America's energy infrastructure is the heart that pumps the American economy. Long-term power outages resulting from an attack on our critical infrastructure could cripple our Nation's economy and put Americans' health and safety in jeopardy. Because the Nation's critical infrastructure is so vital to Americans' way of life, the Federal Government has recognized the necessity of securing our infrastructure from an array of risks, including the threat of an electromagnetic pulse (EMP) attack. The most serious EMP risk would come in the form of an EMP resulting from a nuclear detonation at high altitude. Such an attack could cause long-term damage to the power grid. While many believe the likelihood of such an attack is low, the damage and economic aftershocks that would follow demand that we address these risks. We cannot discount that other nation-states, such as North Korea, or sophisticated terror groups might want to utilize an EMP to wreak havoc on our economy.

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still room for improvement. According to GAO, DHS and the Department of Energy have addressed some but not all of the recommendations in a 2008 report from the Congressionally-authorized EMP Commission.

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Mr. PERRY. The Chair now recognizes the Ranking Member of the subcommittee, the gentlelady from New Jersey, Mrs. Watson Coleman.

Mrs. WATSON COLEMAN. Thank you, Mr. Perry. Thank you for holding today's hearing.

Thank you to Messrs. Chris Currie, Brandon Wales, Joseph McClelland, and Jud Freed for your testimony today.

The Department of Homeland Security is tasked with the overall safety and security of the United States. Last week, the Department revealed a new mission statement: "With honor and integrity, we will safeguard the American people, our homeland, and our values."

One risk to the homeland is an EMP, or electromagnetic pulse—is a burst of electromagnetic radiation that results from suddenly fluctuating magnetic fields. An EMP can be either man-made or natural and can damage high-voltage transformers and possibly contribute to grid failure and electric power blackouts.

EMPs are considered a high-impact, yet low-probability risk occurrence. As DHS tries to prioritize its efforts across a wide spectrum of potential dangers to the Nation, it should take seriously all risks impacting the homeland, not only EMPs but also climate change impacts, solar storms, and a wide range of natural disasters.

Last month, the Government Accountability Office released a report reviewing the Department's assessment and coordination efforts in the EMP space. According to GAO, DHS components, including NPPD, FEMA, and S&T, conduct independent activities addressing EMPs, including research and development, stakeholder coordination, and mitigation. However, no specific component has been tasked with lead responsibility for coordinating activities within the Department or with Federal and industry stakeholders. Further, the Department has not fully leveraged opportunities to

collect key inputs often used in a risk assessment, such as threat vulnerability and consequences information.

Risk assessments are a beneficial means of incorporating methods or tools to reach a specific identifiable conclusion. Specifically, with the use of a risk assessment, the Department can better characterize the risk of EMPs in the overall protection mission.

In 2007, this committee passed the 9/11 Commission Act, which required the Department to produce the Quadrennial Homeland Security Review, a document produced every 4 years for the purpose of comprehensively examining the Department's homeland security strategy and risk priorities. Thus far, 2 QHSRs have been created, and it is my view that the latest 2014 release showed improvement from the 2010 review, but the Department still needs improvement in the way it assesses its risk, such as EMPs.

In the coming weeks, I will introduce legislation that addresses the importance of risk assessment in the development of the QHSR, specifically the need for detailed documented methods for gauging homeland security threats. In order to determine roles and responsibilities for the Department, as GAO suggests, DHS must first determine where EMP fits in the overall protective strategy for the Department.

With that, Mr. Chairman, I yield back the balance of my time.

[The statement of Ranking Member Watson Coleman follows:]

STATEMENT OF RANKING MEMBER BONNIE WATSON COLEMAN

MAY 17, 2016

The Department of Homeland Security is tasked with the overall safety and security of the United States. Last week, the Department revealed a new mission statement: With honor and integrity, we will safeguard the American people, our homeland, and our values.

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In order to determine roles and responsibilities within the Department as GAO suggests, DHS must first determine where EMPs fit in the overall protective strategy for the Department.

Mr. PERRY. The Chair thanks the gentlelady.

Other Members of the subcommittee are reminded that opening statements may be submitted for the record.

[The statement of Ranking Member Thompson follows:]

STATEMENT OF RANKING MEMBER BENNIE G. THOMPSON

MAY 17, 2016

An electromagnetic pulse or EMP is a burst of electromagnetic radiation created when a nuclear weapon is detonated or when a non-nuclear EMP weapon is used. Additionally, naturally-occurring solar weather can generate effects similar to other EMP events.

An EMP could cause catastrophic damage to our Nation's critical infrastructure. An EMP is a high-impact, low-probability risk. Over the past 10 years, 92 percent of counties have had at least 1 Presidential disaster declaration issued; however, none of them were for an EMP.

This does not mean that we should be dismissive of the threat; however, we have the responsibility to examine the Federal Government's efforts, while making sure that we do not use our platforms to promote fear in the minds of the American public.

As the lead agency coordinating the Federal Government's efforts to promote the security and resiliency of the Nation's critical infrastructure, the Department of Homeland Security must take this threat, and all threats to the Nation's critical infrastructure, seriously.

Last month, the Government Accountability Office issued a report detailing the Department's work in the EMP space and determined that DHS has not fully identified its risk assessments when it comes to an EMP attack.

GAO also found that DHS officials could not identify any DHS representatives or offices as having broader designated responsibility for performing key oversight or coordination roles regarding electromagnetic risks within DHS's overall infrastructure protection efforts. According to GAO, stakeholders are unclear who within DHS is responsible for addressing electromagnetic risks.

This leaves me to ask an age-old question that I have asked the Department on several occasions with regard to various responsibilities across several components—"Who's in Charge?" While the Department of Homeland Security is 2 years into its "Unity of Effort" initiative, GAO's findings, while not shocking, are concerning.

This is also troubling because as part of the Department's effort to become more unified, the National Protection and Programs Directorate is looking to Congress for authorization for a reorganization. This reorganization includes having an infrastructure directorate that works with the public and private sectors on threats to physical and cyber infrastructure.

Congressional leaders need to know what if any impact a NPPD reorganization would have on the Department's responsibilities with oversight of the threat from EMP and where EMP fits in the Department's overall infrastructure protection strategy. We also need to know how the infrastructure directorate would plan on working with Federal, State, and local stakeholders when it comes to infrastructure security.

I look forward to the testimony from today's witnesses that can provide greater context to how the Government, in particular DHS, is dealing with the threat from EMP, including how DHS will address risk assessments and continue to work with outside stakeholders.

Finally, I am pleased that the Ranking Member of this subcommittee has taken the initiative to introduce legislation that addresses the importance of risk assessments, and I look forward to cosponsoring her legislation.

Mr. PERRY. We are pleased to have a distinguished panel of witnesses before us today. The witnesses' entire written statements will appear in the record. The Chair will introduce all of the witness first and then recognize each of you for your statements.

At this time, I ask unanimous consent that the statement from the Department of Energy for the record from Patricia Hoffman is entered in the record.

Without objection.

[The information follows:]

STATEMENT OF PATRICIA HOFFMAN, ASSISTANT SECRETARY, OFFICE OF ELECTRICITY DELIVERY AND ENERGY RELIABILITY, U.S. DEPARTMENT OF ENERGY

MAY 17, 2016

Chairman Perry, Ranking Member Watson Coleman, and Members of the subcommittee, thank you for continuing to highlight the importance of a resilient electric power grid. I appreciate the opportunity to address the Department of Energy's role in in helping to ensure a resilient, reliable, and flexible electricity system in an increasingly challenging environment.

Our economy, National security, and even the health and safety of our citizens depend on the reliable delivery of electricity. The mission of the Office of Electricity Delivery and Energy Reliability (DOE–OE) is to strengthen, transform, and improve energy infrastructure to ensure access to reliable, secure, and clean sources of energy. We are committed to working with our public and private-sector partners to protect the Nation's critical energy infrastructure, including the electric power grid, from disruptions caused by natural and man-made events, such as severe weather, physical attacks, cyber attacks, and electromagnetic pulses (EMP).

The electrical grid is more than just infrastructure. It is an ecosystem of asset owners, manufacturers, service providers, and Government officials at Federal, State, and local levels, all working together to run one of the most reliable power grids in the world. Ninety percent of the Nation's energy infrastructure is in private hands, and 3,306 electricity providers serve approximately 148 million customers [1] through a network of 450,000 miles of high-voltage transmission lines.

There are plenty of risks beyond cyber, including physical, severe weather, natural disasters, aging infrastructure, and infrastructure interdependencies. In the face of these diverse threats, we can help ensure that the grid is poised to recover quickly following an incident. Fostering partnerships with public and private stakeholders plays a critical and necessary role in this work.

THE ECOSYSTEM OF RESILIENCE

A crucial factor to meeting these challenges is to be proactive and cultivate what I call an ecosystem of resilience: A network of producers, distributors, regulators, vendors, and public partners, acting together to strengthen our ability to prepare, respond, and recover. We continue to partner with industry, other Federal agencies, local governments, and other stakeholders to quickly identify threats, develop in-depth strategies to mitigate those threats, and rapidly respond to any disruptions.

Our resilience efforts are further bolstered by our broader grid modernization activities, including our support of the research, development, and demonstration of advanced technologies and our work with State, local, Tribal, and territorial stakeholders to help them improve their local resilience and energy emergency response capabilities. Of the $4.5 billion that we invested in grid modernization through the American Recovery and Reinvestment Act (ARRA), $3.4 billion was used to help industry accelerate the deployment of advanced technologies that are now reducing costs and keeping the lights on more reliably and efficiently. This smarter grid is helping to prevent outages, reduce storm impacts, and restore service faster when outages occur.

Our model is partnerships first. We are all in this together. It is through working together that we continue to strengthen our ability to bounce back following an event.

PARTNERSHIPS FOR READINESS

DOE–OE has been working with utility owners and operators, regulators, and State and local officials across the country concerning threats to cybersecurity and other risks. Through these partnerships, we are providing tools, best practices, new technologies, and funds to support their many on-going efforts.

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[1] American Public Power Association (APPA), "U.S. Electric Utility Industry Statistics" *http://www.publicpower.org/files/PDFs/USElectricUtilityIndustryStatistics.pdf*.

We directly support preparedness efforts at the community level, in part through products and tools produced by our Infrastructure Security and Energy Restoration (ISER) division, to inform and educate State and local officials in their energy emergency preparedness activities. This is done through forums, training, and tabletop exercises for Federal, State, and local energy officials.

In early February, DOE Secretary Ernest Moniz signed an updated Energy Emergency Assurance Coordinators (EEAC) Agreement with the National Association of State Energy Officials (NASEO), National Association of Regulatory Utility Commissioners (NARUC), National Governors Association (NGA), and National Emergency Management Association (NEMA). This updated EEAC Agreement lays out concrete items to improve our collective ability to share information, which is essential for making sound response and restoration decisions during emergencies. To support this effort, DOE and State officials will develop information-sharing protocols and processes to streamline response operations. We will also test these processes and information-sharing mechanisms through routine drills and exercises.

The President's fiscal year 2017 budget request includes $15 million for a State Energy Assurance program to foster regional hazard preparedness. This program would focus on providing State, local, Tribal, and territorial governments with analysis, training, and exercising of shared regional risk factors where entities depend on each other for energy supplies and must work together to resolve energy disruptions to restore energy infrastructure.

This new program would be facilitated through competitive regional cooperative assistance awards to State and local partners. As needed, DOE, including our National Laboratory expertise and capability, would be available to the awardees to enhance preparation and allow for real-world energy emergency support. Lessons learned would be shared with other communities to leverage the program across the Nation and help improve resiliency planning.

DOE–OE also focuses on enabling our State, local, and utility partners with information. EAGLE–I (Environment for Analysis of Geo-Located Energy Information), for example, is a DOE-designed and operated web tool that automatically gathers electrical grid service status data from company websites every 15 minutes, and organizes it into an easy-to-read picture of electrical service status Nation-wide. Now covering 75 percent of all U.S. electricity customers, it provides real-time information about the grid—what is up, what is down, the number and location of outages, when service is restored—to DOE and, through our information-sharing efforts, with other Federal agencies.

Geomagnetic Disturbances (GMD) or Space Weather

President Obama and the administration recognize the threat posed by a GMD from space weather and the administration continues to prioritize work to address these concerns. In April 2015, the Quadrennial Energy Review highlighted methods to reduce our electric grid's vulnerabilities to multiple forms of risks. The Secretary of Energy has prioritized DOE efforts to help understand and mitigate these risks for the electricity subsector (subsector).

In 2015 the administration issued the *National Space Weather Strategy* and follow-up National Space Weather Action Plan to better understand and address the risks of geomagnetic storms. The plans gave DOE primary responsibility for 2 of the actions in the Action Plan. First, by the end of 2016, DOE will coordinate with regulatory agencies and the electric power industry to define data requirements that facilitate a centralized reporting system to collect real-time information on the status of the electric power transmission and distribution system during geomagnetic storms. Second, also by the end of 2016, DOE, in coordination with Departments of Homeland Security and Commerce, and stakeholders in the subsector, will develop plans to provide monitoring and data collection systems to inform a system-wide, real-time view of geomagnetically induced currents (GICs) at the regional level and, to the extent possible, display the status of power generation, transmission, and distribution systems during geomagnetic storms.

For several years DOE has taken actions and funded efforts to better understand the risk from space weather. Our space weather strategy included analysis, enhancing science, and collaboration with stakeholders both domestically and internationally. Efforts include:

- Encouraging the development of a North American Reliability Corporation (NERC) GMD task force and supporting it to better understand space weather. The task force developed standards for GMD. In addition to monitoring geomagnetic disturbances, industry is prepared to take action as needed, including reducing load if necessary and changing operational settings to respond to system needs.

- Funding the Electric Power Research Institute's (EPRI) SUNBURST program, a geomagnetically-induced current monitoring system. When our support began there were only 10 monitors, all in the Eastern Interconnection. Now there are over 40 and they are in all 3 major grids in the Continental United States
- Funding a new program to evaluate and install variometers to collect and share data on changes on magnetic fields during GMDs. Our program will put in 12 variometers to help system owners and operators better model the expected potential currents going into transformers causing grid and possible system damage. With the data grid operators can take informed risk-based decisions on actions to mitigate and protect against GMDs. Prior to the deployment of the first variometer, the United States Geological Survey had only 6 magnetometers to measure such data.
- Funding a study at Oak Ridge National Laboratory (ORNL) to evaluate the susceptibility of the eastern grid to GMD. The study will be completed by year's end.
- Organizing, attending, and participating in several space weather workshops with government and industry stakeholders, including those from some of our allies such as Canada, the United Kingdom, and Ireland.

Electromagnetic Pulses (EMP)

DOE has increased its efforts to better understand the EMP threat to the electric grid and what measures can mitigate its potential adverse impacts. DOE plans to take the necessary steps to develop cost-effective strategies for all hazards to mitigate, respond to, and recover from potential disruptions. We have a multi-pronged approach to addressing EMP threats, allowing the subsector to advance readiness for potential EMP impacts through research to quantify the threat, scientific development of mitigation strategies, and analysis of the policies needed for the future.

A recent GAO Report 16–243 from March 2016 presented recommendations to Federal agencies on methods to address EMP. DOE concurred with the report's recommendations to DOE, including that the "Secretary of Energy direct responsible officials to engage with Federal partners and industry stakeholders to identify and implement key EMP research and development priorities, including opportunities for further testing and evaluation of potential EMP protection and mitigation options."

The Fixing America's Surface Transportation Act of 2015 (FAST Act, Pub. L. 114–94) also gives the Department impetus to enhance planning for events such as EMP. In the Act, Congress enhanced the Secretary of Energy's abilities to take emergency actions related to grid operations during a grid security emergency caused by any high-impact event such as an EMP attack.

Other on-going or planned activities related to EMP include:

- The Department is analyzing the vulnerability of the grid to an EMP event and the potential impact on reliability and delivery of electric power. The analysis will examine options such as hardening, blocking, stockpiles, and planning.
- The Department is conducting a risk analysis for "extreme events" including EMP electricity industry planning.
- The Department is working jointly with the Department of Homeland Security through Los Alamos National Laboratory and DHS's National Infrastructure Simulation and Analysis Center to begin developing methods to analyze the impact and consequences of different sources of EMP and GMD events on U.S. electric power infrastructure and to use those methods to determine events of concern.

DOE is committed to helping forge the grid of the future that will be more resilient to all hazards, including EMP. Continued progress in grid modernization is vital to helping us protect the grid from EMP.

PARTNERSHIPS FOR RESPONSE

Our partnerships with private and public stakeholders also focus on quickly identifying threats, developing in-depth strategies to mitigate them and rapidly responding to any disruptions. With 90 percent of the Nation's power infrastructure privately held, coordinating and aligning efforts between the Government and the private sector is the only viable path to success.

Under Presidential Policy Directive–21: Critical Infrastructure Security and Resilience and the FAST Act, DOE is the Sector-Specific Agency (SSA) for electrical infrastructure. The SSA plays the pivotal role of ensuring unity of effort and message across Government partners, including the Department of Homeland Security, the Department of Defense, and DOE offices.

As the Energy SSA we also serve as the day-to-day Federal interface for the prioritization and coordination of activities to strengthen the security and resilience

of critical infrastructure in the electricity subsector. This involves building, maintaining, and advancing our relationships and collaborative efforts with the energy sector. We have invested in public/private partnership programs and initiatives that involve sharing real-time information, assessing vulnerabilities, clarifying responsibilities, and engaging in training and exercises.

In addition, the Department of Energy serves as the lead agency for Emergency Support Function 12 (ESF–12) under the National Response Framework. As the lead for ESF–12, the DOE is responsible for facilitating the restoration of damaged energy infrastructure. During a response operation, the Department works with industry and Federal/State/local partners to:

- Assess disaster impacts on local and regional energy infrastructure;
- Coordinate asset delivery to repair damaged infrastructure;
- Monitor and report on restoration efforts; and
- Provide regular situational awareness updates to key decision makers in the administration and our interagency partners.

To achieve these operational priorities, the Department deploys responders who work directly with the affected utilities and local officials on the ground during a disaster. The responders provide expertise on a variety of energy issues, and have direct access to our subject-matter experts in Washington, DC who work with our interagency partners to coordinate the appropriate waivers, when needed, to further speed restoration efforts. In extreme cases, the Department can use its legal authorities under the Federal Power Act, Defense Production Act, and other statutes to assist in response and recovery operations.

The National electricity infrastructure spans 19,000 power plants, 450,000 miles of transmission lines, 55,000 substations, and 6 million miles of distribution lines. The grid is truly a National system of complex systems, where small variations in power output or quality can be felt almost instantly several States away. That said, every piece of that infrastructure is local.

Threats ranging from a fallen tree to a dedicated hacker from overseas can threaten the broader transmission system and the distribution system. When the power goes out, the local utility is the first responder. Should any threat or emergency exceed local public or private resources or require a full-blown National response, a utility CEO, a representative trade association member of the Electricity Subsector Coordinating Council (ESCC), the Electricity Information Sharing and Analysis Center (E–ISAC), or the Federal Government can request what is called a Crisis State Activity. Crisis State Activities are coordinated through the ESCC because, as with preparedness, we respond through partnerships. The ESCC is a group of leaders from across the electricity subsector that meet regularly with Government to coordinate and share information. Together, we work toward collective actions to address the threat or risk.

Congress enacted several important new energy security measures in the FAST Act. The Secretary of Energy was provided a new authority, upon declaration of a Grid Security Emergency by the President, to issue emergency orders to protect or restore critical electric infrastructure or defense critical electric infrastructure. This authority allows DOE to respond as needed to the threat of cyber and physical attacks on the grid. DOE is developing a proposed rule of procedure regarding this new authority.

The FAST Act codifies DOE's role as the lead SSA for energy sector cyber incident coordination. These actions provide a central point of contact for the energy sector and can expedite recovery from cyber and physical incidents.The FAST Act protections afforded to critical electric infrastructure information provide essential information-sharing tools to enhance the Federal Government's situational awareness while assuring the private sector that sensitive information on vulnerabilities will be safeguarded. DOE looks forward to consulting on the forthcoming Federal Energy Regulatory Commission (FERC) critical electric infrastructure information ruling.

The FAST Act will also enable a more robust response for energy incidents, and DOE is on track to implement the energy security provisions.

PARTNERSHIPS FOR INNOVATION

Innovation and preparedness are vital to grid resilience. In January 2016, the DOE built upon its Grid Modernization Initiative—an on-going effort that reflects the Obama administration's commitment to improving the resiliency, reliability, and security of the Nation's electricity delivery system—by releasing a comprehensive new Grid Modernization Multi-Year Program Plan (MYPP). The MYPP, developed in close collaboration with a wide range of key external partners, lays out a blueprint for DOE's research, development, and demonstration agenda to enable a modernized grid, building on concepts and recommendations from the first installment

of the Quadrennial Energy Review (QER) and Quadrennial Technology Review (QTR).

For example, large power transformers are critical to grid resilience, and are ripe for innovation. These important grid assets can weigh hundreds of tons, are expensive, and are typically custom made with procurement lead times of a year or more. A significant number of damaged transformers from any type of hazard could result in a long-term impact on the overall resilience of the grid. The QER recognized the risks associated with the loss of large power transformers. The QER recommended that DOE work with other Federal agencies, States, and industry on an initiative to mitigate these risks. Approaches envisioned in the QER include the development of 1 or more strategic transformer reserves through a staged process, beginning with an assessment of technical specifications and whether new Federal regulatory authorities or cost-share are necessary and appropriate.

The Transformer Resilience and Advanced Components (TRAC) program includes a number of R&D activities to improve the resilience of transformers. Replacing aging grid assets with outdated technology leads to infrastructure lock-in that increases the total cost of grid modernization. The typical lead time between a large power transformer order and delivery ranges from 5 to 12 months for domestic producers and 6 to 16 months for producers outside the United States. The President's fiscal year 2017 budget request of $15 million for TRAC will help develop cost-effective, next-generation components that are inherently more resilient.

The FAST Act (Sec. 61004) also addressed this issue and requires DOE in consultation with FERC, the ESCC, Energy Reliability Organization (ERO), and owners and operators of critical electric infrastructure to submit a plan to Congress evaluating the feasibility of establishing a Strategic Transformer Reserve for the storage, in strategically-located facilities, of spare large power transformers in sufficient numbers to temporarily replace critically damaged large power transformers. The plan is to include an analysis of the degree to which electricity subsector initiatives including utility ownership, sharing agreements, etc., satisfy needs and funding options including fees on owners and operators and public-private cost share with industry. In January, DOE–OE awarded the analysis project to a team led by the Oak Ridge National Laboratory. The team includes researchers from the University of Tennessee–Knoxville, Sandia National Laboratories, the Electric Power Research Institute, and Dominion Virginia Power.

Secretary Moniz also announced last January an award of up to $220 million over 3 years, subject to Congressional appropriations, to DOE's National Laboratories and partners to support critical research and development in advanced storage systems, clean energy integration, standards and test procedures, and a number of other key grid modernization areas. This Grid Modernization Laboratory Consortium effort recognizes regional differences and will strengthen regional strategies while defining a diverse and balanced National strategy. In addition to projects that address the needs of incorporating individual grid technologies like solar or energy storage, DOE is also developing cross-cutting projects that have an impact across multiple technologies. As Secretary Moniz said at the announcement, "Modernizing the U.S. electrical grid is essential to reducing carbon emissions, creating safeguards against attacks on our infrastructure, and keeping the lights on."

Energy storage is a key technology for whole-grid resilience. Energy storage fundamentally changes the relationship between when energy is produced and when it is consumed. The President's fiscal year 2017 budget request supports OE's work on materials research, device development, demonstrations, and grid analysis to help transition selected energy storage technologies from R&D to industrially relevant scales with improved safety, industry acceptance, and reduced cost. Improved energy storage technologies will enable the stability, resiliency, and reliability of the future electric utility grid, as well as increased deployment of variable renewable energy resources.

We have been proactive in advancing technologies to modernize and make our grids smarter and more adaptive to the challenges posed by threats to the grid. For example, DOE–OE has made key investments in the area of synchrophasor technology, which reduces grid vulnerabilities by providing timely and accurate power outage information and better self-healing capabilities, and has also invested in microgrids, which keep local communities up and running during regional and other outages and help supply power to affected areas.

Many of these projects are working in local jurisdictions throughout the United States. Supporting the research, development, and deployment of next-generation technologies enhances the grid's ability to recover quickly from disruptions.

CONCLUSION

Threats continue to evolve, and DOE is working diligently to stay ahead of the curve. The solution is an ecosystem of resilience that works in partnership with local, State, and industry stakeholders to help provide the methods, strategies, and tools needed to help protect local communities through increased resilience and flexibility. To accomplish this, we must accelerate information sharing to inform better local investment decisions, encourage innovation and the use of best practices to help raise the energy sector's security maturity, and strengthen local incident response and recovery capabilities, especially through participation in training programs and disaster and threat exercises.

Building an ecosystem of resilience is—by definition—a shared endeavor, and keeping a focus on local communities remains an imperative. Because DOE has spent decades building—and continues to build—local partnerships and investing in technologies to enhance resilience, the grid is better able to withstand and recover quickly from disasters and attacks.

Mr. PERRY. All right. Mr. Chris Currie is the director of GAO's Homeland Security and Justice Team, where he leads the agency's work on emergency management, National preparedness, and critical infrastructure protection issues. In this role, he evaluates Federal efforts and programs to prevent, plan for, and respond to natural and man-made disasters. Prior to this position, he served as an acting director in GAO's Defense Capabilities and Management Team, where he led reviews of Department of Defense programs.

Welcome.

Mr. Brandon Wales is the director of the Office of Cyber and Infrastructure Analysis at the Department of Homeland Security. His office provides integrated analysis of cyber and physical risk to the Nation's critical infrastructure. Previously, Mr. Wales was the director of the Homeland Infrastructure Threat and Risk Analysis Center.

Welcome.

Mr. Joseph McClelland is the director of the Office of Energy Infrastructure Security at the Federal Energy Regulatory Commission, or FERC. His works with Federal and State agencies and the energy industry to minimize risk to the Nation's energy infrastructure. Mr. McClelland joined the Commission in 2004 and has more than 20 years of experience in the electric utility industry. He is a graduate of the Pennsylvania State University.

Welcome.

Mr. Judson Freed is the director of the Office of Emergency Management and Homeland Security for Ramsey County, Minnesota—thanks for traveling here today, sir—and is testifying on behalf of the National Association of Counties in his capacity as the vice chair of its subcommittee on homeland security and emergency management. The association represents elected and appointed officials in over 3,000 counties across the Nation.

Thank you all for being here today.

The Chair now recognizes Mr. Currie for your statement, sir.

STATEMENT OF CHRIS P. CURRIE, DIRECTOR, HOMELAND SECURITY AND JUSTICE ISSUES, U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Mr. CURRIE. Well, thank you, Chairman Perry, and thank you, Ranking Member Watson Coleman, as well, and other Members of the subcommittee. I appreciate the chance to be here to discuss our recent report on Federal efforts to address electromagnetic risks.

Within the United States, there are 16 critical infrastructure sectors—for example, water, transportation, communications, and, of course, energy. The energy sector ties all of these sectors together, and without it the others can't function. This makes protecting it a National security priority.

One of the greatest threats to the electric grid is an EMP, or electromagnetic pulse; also, a natural solar weather event. These are also called GMDs, or geomagnetic disturbances. Both could cause large power outages over a long period of time.

The concern was so great that Congress established the EMP Commission in 2001. It issued reports in 2004 and 2008, and most of the recommendations were aimed at the Departments of Homeland Security and Energy.

Now, DHS and DOE are not required in law to implement the Commission recommendations; however, we found that many of the recommendations align with responsibilities that both departments already have. For example, various laws and Presidential directives already require DHS and DOE to assess the risks to critical infrastructure assets and prioritize those.

DHS, DOE, and FERC have all taken some action, as the Chairman noted, to address electromagnetic risks. Most of these actions are indirect, since electric infrastructure is mainly owned by the private sector. But here are some examples:

DHS and DOE have invested in research to study the vulnerability of large, high-voltage transformers to EMPs, GMDs, and other natural disasters. These transformers are particularly critical to our electric grid. They are also expensive, large, and difficult to replace quickly.

In the response area, FEMA is developing a specific plan to address long-term power outages, and while it is not specific to electromagnetic risks, this plan would describe how the Federal Government would respond and recover from a long power outage.

Just to be clear, while some of these actions align with certain EMP Commission recommendations, there has not been a comprehensive, holistic effort to address them. There are still whole or part recommendations that remain open.

Now, the next question is, what more should we expect the Federal Government to do? We found several areas where Federal efforts need to be strengthened.

First, it wasn't clear and, frankly, there was a bit of confusion within DHS for who exactly should be responsible for electromagnetic risks. As I mentioned, various components took action, but there is no designated lead for coordinating all of these efforts together. We think this is important, not just to clarify things within DHS, but also so DHS's partners, like DOD, DOE, FERC, and the industry, know who to work with. We recommended that DHS designate roles and responsibilities, and they fully agreed with that.

We also found that much more needs to be done to identify and prioritize key electric-sector infrastructure. Neither DHS nor DOE could identify actions in this area. While FERC did conduct a review in 2013 of certain critical electric-sector substations, DHS and DOE were not involved at that time. What we recommended is that DHS and DOE review FERC's assessment and determine what

more needs to be done to assess and prioritize assets. Both agencies fully agreed with us and are now taking some action to address that.

Last, more needs to be done to coordinate and prioritize efforts across the departmental stovepipes. This includes areas like research and the testing and development of mitigation and protection technologies. Recently, there's been more focus and coordination on natural solar events through efforts like the White House National Space Weather Action Plan, but this plan addresses only natural events, not EMPs.

We recommend that DHS and DOE better coordinate with each other and the industry—and that is critical—to identify and implement EMP research and development priorities. Importantly, this would include coordinating to test and evaluate potential EMP protection options. Both agencies agreed and told us they plan to work with industry over the next year or so to develop that.

So we will continue to monitor DHS and DOE's progress in implementing these recommendations moving ahead. That completes my prepared remarks. I would be happy to answer your questions.

[The prepared statement of Mr. Currie follows:]

PREPARED STATEMENT OF CHRIS P. CURRIE

MAY 17, 2016

CRITICAL INFRASTRUCTURE PROTECTION.—FEDERAL EFFORTS TO ADDRESS ELECTROMAGNETIC RISKS

GAO–16–641T

Chairman Perry, Ranking Member Watson Coleman, and Members of the subcommittee: I am pleased to be here today to discuss our March 2016 report on Federal efforts to address electromagnetic risks to the electric grid.[1] Electromagnetic risks caused by a man-made electromagnetic pulse (EMP) or a naturally-occurring solar weather event could have a significant impact on the Nation's electric grid as well as other infrastructure sectors that depend on electricity, such as communications. The impact of these events could lead to power outages over broad geographic areas for extended durations. Addressing these events necessitates effective collaboration among multiple Government agencies and industry partners, as no single Federal program or entity has sole responsibility for addressing electromagnetic risks. In April 2008, the Commission to Assess the Threat to the United States from Electromagnetic Pulse Attack (EMP Commission)[2] issued a report that included

[1] GAO, *Critical Infrastructure Protection: Federal Agencies Have Taken Actions to Address Electromagnetic Risks, but Opportunities Exist to Further Assess Risks and Strengthen Collaboration,* GAO–16–243 (Washington, DC: Mar. 24, 2016).

[2] Established pursuant to the National Defense Authorization Act for Fiscal Year 2001, the EMP Commission was responsible for assessing the following: (1) The nature and magnitude of potential high-altitude EMP threats to the United States; (2) the vulnerability of U.S. military and civilian systems to an EMP attack in terms of emergency preparedness; (3) the capability of the United States to repair and recover from damage inflicted by an EMP attack; and (4) the feasibility and cost of hardening selected military and civilian systems against EMP attack. See Pub. L. No. 106–398, §§ 1401–09, 114 Stat. 1654, 1654A–345–348 (2000). See also Pub. L. No. 109–163, § 1052, 119 Stat. 3136, 3434–35 (2006) (reestablishing the EMP Commission to continue its efforts to monitor, investigate, make recommendations, and report to Congress on the evolving threat to the United States in the event of an EMP attack resulting from the detonation of a nuclear weapon or weapons at high altitude) and Pub. L. No. 110–181, Div. A, § 1075 122 Stat. 3, 333 (2008) (providing, among other things, that the EMP Commission and the Secretary of Homeland Security shall jointly ensure that the work of the EMP Commission with respect to EMP attack on electricity infrastructure, and protection against such attack, is coordinated with DHS efforts on such matters). The National Defense Authorization Act for Fiscal Year 2016 once again reestablishes the EMP Commission but with an expanded purpose that includes the evolving threat from, among other things, non-nuclear EMP weapons and natural EMP generated by geomagnetic storms. See Pub. L. No. 114–92, § 1089, 129 Stat. 726, 1015–16 (2015).

over 90 recommendations addressing the preparation for, and protection and recovery from, a possible EMP attack against U.S. critical infrastructure. The majority of these recommendations were made to the Department of Homeland Security (DHS) and to the Department of Energy (DOE).

According to experts, a nuclear EMP is the burst of electromagnetic radiation resulting from the detonation of a nuclear device, which can disrupt or destroy electronic equipment. Non-nuclear EMP weapons can also be designed to intentionally disrupt electronics, but these generally have short range and are not a threat to multiple assets. In addition to man-made EMPs, naturally-occurring solar weather events of sufficient intensity can also cause electromagnetic impacts that can adversely affect components of the commercial electric grid, as well as other infrastructure such as satellites and undersea cables. The resulting impact of a solar weather event is commonly referred to as a geomagnetic disturbance (GMD). In 1989, a GMD caused wide-scale impacts on the Hydro-Quebec power system in Canada which caused this regional electric grid to collapse within 92 seconds and left 6 million customers without power for up to 9 hours.

The National Infrastructure Protection Plan (NIPP) outlines the roles and responsibilities of DHS and applicable sector-specific agencies for each of the 16 critical infrastructure sectors.[3] DHS has the lead role in coordinating the overall Federal effort to promote the security and resilience of the Nation's critical infrastructure and DOE—as the sector-specific agency for the energy sector, which includes critical electrical infrastructure—shares responsibility with DHS. Other Federal agencies working to address the threat of EMP and GMD include the Department of Defense (DOD) and the Federal Energy Regulatory Commission (FERC), as well as the National Oceanographic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), and the National Aeronautics and Space Administration (NASA).

As noted in Presidential Policy Directive 21, the energy and communications sectors are uniquely critical due to the enabling functions they provide to other critical infrastructure sectors.[4] The U.S. electric power delivery system is a highly complex network of substations and electric lines that transport electricity from generators to residential, commercial, and industrial consumers. Approximately 85 percent of the Nation's critical electrical infrastructure is owned and operated by private industry.

My statement today summarizes the findings from our March 2016 report, and like the report, addresses: (1) The extent to which key Federal agencies have taken actions to address electromagnetic risks to the electric grid, including how these actions align with selected recommendations from the 2008 EMP Commission report and (2) the extent to which additional opportunities, if any, exist to enhance Federal efforts in addressing those risks to the electric grid. To conduct this work, we reviewed program documents, research reports, applicable risk assessments, and other supporting documentation related to electromagnetic risks and interviewed agency officials at DHS, DOE, DOD, FERC, and NOAA. We also interviewed officials from industry associations, subject-matter experts from research organizations, product manufacturers, and electric utility operators. More detailed information on our scope and methodology can be found in our March 2016 report.[5] We conducted the work on which this statement is based in accordance with generally accepted Government auditing standards.

FEDERAL AGENCIES HAVE TAKEN VARIOUS ACTIONS TO ADDRESS ELECTROMAGNETIC RISKS; SOME ACTIONS ALIGN WITH THE 2008 EMP COMMISSION RECOMMENDATIONS

DHS, DOE, and FERC have taken various actions to address electromagnetic risks to the electric grid, and these actions generally fall into 4 categories: (1) Standards, guidelines, tools, and demonstration projects; (2) research reports; (3) strategy development and planning; and (4) training and outreach. Additionally, some of the actions DHS and DOE have taken generally aligned with recommendations made by the EMP Commission.

Because Federal agencies generally do not own electric grid infrastructure, Federal actions to address GMD risks are more indirect through such things as devel-

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[3] DHS, *National Infrastructure Protection Plan, Partnering for Critical Infrastructure Security and Resilience* (Washington, DC: December 2013). Sector-specific agencies are the Federal departments and agencies responsible for providing institutional knowledge and specialized expertise, as well as leading, facilitating, or supporting the security and resilience programs and associated activities of their designated critical infrastructure sector in the all-hazards environment.

[4] Presidential Policy Directive–21, *Critical Infrastructure Security and Resilience* (Feb. 12, 2013) (identifying, among other things, the 16 critical infrastructure sectors and the sector-specific agencies).

[5] GAO–16–243.

oping standards and guidelines, and conducting research that could benefit electric grid owners and operators. Federal agencies have also been involved in strategy development and planning, as well as training and outreach efforts, as a means of preparing Federal officials and others to respond to both EMP and GMD events, and enhancing knowledge about electromagnetic risks. For example, DHS's Science and Technology Directorate (S&T) led the design and development of a prototype transformer that can be more easily transported to another location to help restore electric power in a timelier manner. DHS has also participated in various training and outreach events to enhance understanding of EMP and GMD events. DOE's primary efforts include supporting research to enhance the understanding of the potential impacts to the electric grid from electromagnetic events. More detailed information on key Federal agencies' actions taken since 2008 to address electromagnetic risks can be found in Appendix II of our March 2016 report.[6]

Although DHS and DOE did not report that any of their actions were taken in response to the EMP Commission recommendations, some actions taken by both agencies have aligned with some of the recommendations. Specifically, of the 7 recommendations made by the EMP Commission related to the electric grid,[7] some of the actions that DHS and DOE took aligned with 4 of them: Conducting research to better understand the interdependencies of critical infrastructures, addressing the vulnerability of control systems to an EMP attack; identifying responsibilities for responding to an EMP attack; and utilizing industry and other Governmental institutions to assure the most cost-effective outcomes.[8] For example, with respect to the recommendation on conducting research to better understand interdependencies of critical infrastructures, DHS's *Sector Resilience Report: Electric Power Delivery* includes some assessment of how various critical infrastructures—including the energy, communications, and transportation sectors, among others—are interdependent in maintaining operations. For more detailed information regarding how identified Federal actions align with these 7 EMP Commission recommendations, see Appendix III of our March 2016 report.[9]

ADDITIONAL OPPORTUNITIES EXIST TO ENHANCE FEDERAL EFFORTS TO ADDRESS ELECTROMAGNETIC RISKS TO THE ELECTRIC GRID

DHS Has Not Clearly Identified Roles and Responsibilities for Addressing Electromagnetic Risks

In our March 2016 report, we found that DHS had not clearly identified internal roles and responsibilities for addressing electromagnetic risks to the electric grid or communicated these to external Federal and industry partners. While multiple DHS components and offices, including the National Protection and Programs Directorate (NPPD), the Federal Emergency Management Agency (FEMA), and S&T, had each conducted independent activities addressing electromagnetic risks to the electric grid, none had been tasked with lead responsibility for coordinating related activities within the Department or with Federal and industry stakeholders. As a result, during the course of our review for our March 2016 report, we experienced on-going challenges in identifying applicable DHS personnel and related Departmental actions. For example, NPPD officials had difficulty identifying their specific roles and activities addressing electromagnetic risks to the electric grid, including efforts to collect or synthesize available risk information to provide input into Department-wide risk assessments.

Furthermore, industry representatives and other Federal officials told us it is not clear who within DHS is responsible for addressing electromagnetic risks. The 2008 EMP Commission report recommended that DHS make clear its authority and responsibilities, as well as delineate the functioning interfaces with other Governmental institutions, regarding EMP response efforts. We concluded that designating internal roles and responsibilities within DHS regarding electromagnetic risks and

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[6] GAO–16–243.

[7] The 7 EMP Commission recommendations related to the electric grid include the following: (1) Conducting research to better understand infrastructure systems and interdependencies; (2) expanding activities to address the vulnerability of control systems; (3) identifying clear authority and responsibility to respond to an EMP attack; (4) engaging Federal and industry entities to determine liabilities and funding; (5) establishing monitoring efforts and defining testing standards and metrics; (6) providing capabilities to help protect the electric grid from an EMP attack and recover as rapidly and effectively as possible; and (7) utilizing industry and Governmental institutions to assure cost-effective outcomes.

[8] With regard to the last multi-part recommendation identified above, DHS and DOE took some actions that aligned with 5 of the 15 subparts of this recommendation. Some of the subparts include such efforts as developing National and regional restoration plans and assuring the availability of critical communication channels, among other efforts.

[9] GAO–16–243.

communicating these to Federal and industry partners could provide additional awareness of related activities and help ensure more effective and coordinated engagement with other Federal agencies and industry stakeholders, and could help reduce the risk of potential duplication, overlap, or fragmentation within the Department or across Federal agencies.

In our March 2016 report, we recommended DHS designate roles and responsibilities within the Department for addressing electromagnetic risks and communicate these to Federal and industry partners. DHS concurred with our recommendation and reported that their Office of Policy is coordinating across the Department to identify and document applicable roles and responsibilities regarding electromagnetic issues to ensure full mission coverage while minimizing potential overlap or redundancy and expects to complete this effort by December 2016. These actions, if implemented effectively, should address the intent of our recommendation.

DHS and DOE Have Not Fully Addressed NIPP Requirement to Identify Key Electrical Infrastructure Assets

In our March 2016 report, we found that DHS and DOE had not taken actions to identify key electrical infrastructure assets as required given their respective critical infrastructure responsibilities under the NIPP. The NIPP explicitly states that to manage critical infrastructure risk effectively, partners must identify the assets, systems, and networks that are essential to their continued operation, considering associated dependencies and interdependencies of other infrastructure sectors. The 2008 EMP Commission report also recommended that DHS and DOE prioritize nodes that are critical for the rapid recovery of other key sectors that rely upon electricity to function, including those assets that must remain in service or be restored within hours of an EMP attack. Neither DHS nor DOE reported any specific actions taken to identify critical electrical infrastructure as part of risk management efforts for the energy sector, including any systematic review of a 2013 FERC analysis of critical substations, or any further collaboration to determine the key elements of criticality that they believe should be considered when evaluating the vast array of infrastructure assets constituting the U.S. electric grid. The extensive size and scope of the electric power system necessitates collaboration among partners to ensure all individual expertise is effectively leveraged.

As a result, we recommended in our March 2016 report that DHS and DOE direct responsible officials to review FERC's electrical infrastructure analysis and collaborate to determine whether further assessment is needed to adequately identify critical electric infrastructure assets. DHS and DOE each concurred with our recommendation. DHS reported that NPPD is to collaborate with FERC to identify critical electrical infrastructure assets beginning with the evaluation of critical substations identified by FERC, and will explore elements of criticality that might not have been considered by FERC, in coordination with DOE. DOE stated that its Office of Electricity Delivery and Energy Reliability will review FERC's electrical infrastructure analysis and will work with FERC and DHS to identify any additional elements of criticality and determine if further assessment is needed. Both DHS and DOE expect to complete these efforts by March 2017. These actions should address the intent of our recommendation.

DHS Has Not Fully Leveraged Existing Opportunities to Collect and Analyze Information on Electromagnetic Risks

We found in March 2016 that although DHS components had independently conducted some efforts to assess electromagnetic risks, the Department had not fully leveraged available risk information or conducted a comprehensive analysis of these risks. Within the Office of Policy, there is recognition that "space weather" and "power grid failure" are significant risk events, which DHS officials have determined pose great risk to the security of the Nation. However, DHS officials were unable to provide detailed information about the specific risk inputs—namely threat, vulnerability, and consequence information—that were used to assess how electromagnetic events compared to other risk events, or how these inputs were used to inform DHS's applicable risk-management priorities. Further, officials within NPPD were unable to identify any specific actions taken or plans to systematically collect or analyze risk information regarding electromagnetic impacts to the electric grid as part of Department-wide risk assessment efforts.

According to the NIPP, to assess risk effectively, critical infrastructure partners—including owners and operators, sector councils, and Government agencies—need timely, reliable, and actionable information regarding threats, vulnerabilities, and consequences. Additionally, the electric grid remains vulnerable to other potential threats, such as physical and cyber attacks. We concluded that better collection of threat, vulnerability, and consequence information through existing DHS programs

and strengthened collaboration with Federal partners could help DHS better assess the relative risk ranking of electromagnetic events versus other risks and help inform asset protection priorities. Moreover, according to subject-matter experts, the impact to the electric grid from electromagnetic threats may vary substantially by location, network, and operating characteristics, and other factors. For example, key reports on GMD indicate that high-voltage transformers located at higher latitudes in the United States are likely subject to increased potential for adverse impacts from GMD events than those at lower latitudes. Further collection of information on sector interdependencies could also help DHS to assess the potential economic consequences associated with long-term power outages and provide information to help assess the cost-effectiveness of various mitigation strategies.

In our March 2016 report, we recommended that DHS's NPPD and Office of Infrastructure Protection (IP) work with other Federal and industry partners to collect and analyze key inputs on threat, vulnerability, and consequences related to electromagnetic risks. DHS concurred with our recommendation and reported that the Department has initiated efforts to assess electromagnetic risk and help determine priorities. For example, DHS stated the Department has a joint study with DOE under way that will analyze the hazard environments, impacts, and consequences of different sources of EMP and GMD on the electric grid to determine events of concern and potential means of mitigation. DHS expects to implement these efforts by December 2016 and if implemented effectively, should address the intent of our recommendation.

Federal Agencies Have Not Fully Coordinated Efforts to Implement EMP Risk Management Activities

We also found in March 2016 that key Federal agencies, including DHS and DOE, as well as industry partners had not established a fully coordinated approach to identifying and implementing risk management activities to address EMP risks. According to the NIPP Risk Management Framework, such activities include identifying and prioritizing research and development efforts, and evaluating potential mitigation options, including the cost-effectiveness of specific protective equipment. The publication of the National Space Weather Action Plan in October 2015 identified many key Federal activities in these areas regarding the GMD risk; however, no similar efforts had been proposed regarding EMP risks to the electric grid.[10]

DHS officials stated an EMP attack generally remains a lower-risk priority compared to other risk events with higher probability such as natural disasters or cyber attacks. DOE officials also noted resource limitations and competing priorities as the key driver for not pursuing additional risk management activities specifically related to EMP events. However, we found that even if an EMP attack is not determined to be among the highest-resource priorities for DHS and DOE relative to other risk events, there are opportunities for enhanced collaboration among Federal agencies and industry stakeholders to address identified gaps and help ensure that limited resources are more effectively coordinated and prioritized. For example, recent reports issued by DOE and a leading research organization for the electric industry identified gaps in the information available regarding likely EMP impacts to modern grid technologies and electronic control systems. They noted that such information remains important for developing applicable protective guidelines and equipment design specifications.

In our March 2016 report, we recommended that DHS and DOE engage with Federal partners and industry stakeholders to identify and implement key EMP research and development priorities, including opportunities for further testing and evaluation of potential EMP protection and mitigation options. DHS and DOE concurred with our recommendation and each identified actions to convene applicable stakeholders to jointly determine mitigation options and conduct further testing and evaluation. DHS stated S&T will work with DOE and the Electricity Subsector Coordinating Council to develop a joint Government and industry approach to identify options for mitigating the consequences of an EMP event. DHS expects to implement this effort by September 2016. In addition, DOE stated it is working with the Electric Power Research Institute to develop an EMP Strategy that is scheduled for completion by August 31, 2016, and the strategy is to be followed by a more detailed action plan identifying research and development priorities and specific opportunities to test and evaluate EMP mitigation and protection measures. If implemented

[10] White House, *National Space Weather Action Plan* (Washington, DC: October 2015). Among other actions, the National Space Weather Action Plan lays out responsibilities for Federal entities to establish benchmarks for space weather events, which are intended to serve as inputs into such activities as developing vulnerability assessments, creating engineering standards, and developing more effective mitigation practices and procedures.

effectively, DHS and DOE's actions should address the intent of our recommendation.

We will continue to monitor DHS and DOE actions taken to address our March 2016 recommendations and have also recently initiated two additional reviews. One is evaluating the electromagnetic event preparedness of U.S. electricity providers and the other is a technical assessment of protective equipment designed to mitigate the potential impacts of a GMD on electrical infrastructure. We expect these projects to be completed by mid-2017.

Chairman Perry, Ranking Member Watson Coleman, and Members of the subcommittee, this completes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

Mr. PERRY. Thank you, Mr. Currie.

The Chair recognizes Mr. Wales for his opening statement.

STATEMENT OF BRANDON WALES, DIRECTOR, OFFICE OF CYBER AND INFRASTRUCTURE ANALYSIS, NATIONAL PROTECTION AND PROGRAMS DIRECTORATE, U.S. DEPARTMENT OF HOMELAND SECURITY

Mr. WALES. Thank you, Chairman Perry, Ranking Member Watson Coleman, and distinguished Members of the committee. It is my pleasure to be here to discuss the threat posed by electromagnetic pulse events, or EMP, to our Nation and our critical infrastructure.

Over the past several decades, the risk to digital and physical infrastructures has grown. Today's power grid and information networks may be more vulnerable to EMP than those from a few decades ago as the grid transitions from an analog to a digital system.

My testimony today will focus on the Department of Homeland Security's efforts to prepare for, respond to, and recover from a potential EMP attack, as well as touch on the joint DHS-Department of Energy effort to review the EMP science and provide a peer-reviewed estimate of potential risks.

As you know, an EMP is the burst of electromagnetic radiation created when a nuclear weapon is detonated or when a non-nuclear EMP weapon is used. EMPs can be high-frequency, similar to a flash of lightning, or low-frequency, similar to an aurora-induced phenomenon.

The consequences of an EMP can range from permanent physical damage to temporary system disruptions and can result in fires, electric shocks to people and equipment, and critical service outages. EMP in some of its forms can cause wide-spread disruption and serious damage to electronic devices and networks, including those upon which many critical infrastructures rely.

All critical infrastructure sectors are at risk from EMP, particularly those sectors that rely heavily on the electric grid and communications and information technology, such as industrial control systems. The complex interconnectivity among critical infrastructure sectors means that EMP incidents will likely create cascading failures across sectors.

We recognize that the Federal Government plays an important role supporting the critical infrastructure community manage risks from low-probability, high-consequence events, such as EMPs and severe geomagnetic disturbances. DHS and its interagency partners are using our unique resources, built over the past decade, to address the scale and degree of uncertainty associated with EMP risk.

DHS has been working on the topic of EMP for a number of years, and we will continue working collaboratively both internally and with external stakeholders in various arenas to address the recommendations issued by the Government Accountability Office on this issue.

The Office of Cyber and Infrastructure Analysis within DHS's National Protection and Programs Directorate has partnered with the Department of Energy's Office of Electricity Delivery and Energy Reliability to assess the impacts of EMP and geomagnetic disturbance events on electric power assets.

This study, facilitated through DHS's National Infrastructure Simulation and Analysis Center and DOE's National Laboratories, is intended to develop scientifically rigorous, peer-reviewed methods for assessing electric power asset impacts from EMP events. This study will include participation from the intelligence community, the broader interagency, the academic community, and the private sector when possible. We expect to complete this study in mid-2017.

Our work also benefits from the activities of DHS's National Cybersecurity and Communications Integration Center, or NCCIC. The NCCIC is an essential conduit within DHS to share information between the interagency community and the private sector on risks to the communication and control elements of our infrastructure systems and has conducted past studies on EMP risks to communications infrastructure.

In addition, the Office of Infrastructure Protection has a long history of working with the private sector to enhance electric grid security and resilience. This office conducts and facilitates vulnerability and resilience assessments to help critical infrastructure owners and operators and State, local, Tribal, and territorial partners understand and address risks to their critical infrastructure.

I would also like to recognize my colleagues' activities at the Science and Technology Directorate and the Federal Emergency Management Agency.

The Science and Technology Directorate has a mission to deliver effective and innovative insight, methods, and solutions for the critical needs of the homeland security enterprise. Past research efforts on electric grid resilience have resulted in successes, such as the recovery transformer project, which is available to be deployed by the private sector today for risk reduction against a variety of hazards.

Finally, the Federal Emergency Management Agency leads Federal efforts to respond to and recover from impacts of a wide-spread disruption in the power grid regardless of cause. Through the development of the Power Outage Incident Annex, a collaboration of the Federal Government and the private sector, FEMA is enhancing the existing response and recovery Federal interagency operational plans.

The Department of Homeland Security has since its inception pursued a deeper understanding of the EMP threat as well as its potential impacts and effective mitigation strategies. These efforts have been undertaken in cooperation with other Federal agencies and the private sector, and we are committed to continuing to expand our focus on this issue as warranted by the risk environment.

The Department takes seriously the recent review and recommendations of the Government Accountability Office on Federal efforts to address EMP risk and welcomes further cooperation with other Government agencies to ensure we are appropriately responsive on this critical topic.

I want to thank the committee for the invitation to speak here today and for your on-going support for our work in this area. Thank you.

[The prepared statement of Mr. Wales follows:]

PREPARED STATEMENT OF BRANDON WALES

MAY 17, 2016

Thank you, Chairman Perry, Ranking Member Coleman, and distinguished Members of the committee. It is my pleasure to be here to discuss the threat posed by electromagnetic pulse events (EMP) to our Nation and its critical infrastructure, including its cyber, communications, and electric-grid assets.

Over the past several decades, the risk to digital and physical infrastructures has grown. For example, today's power grid and information networks may be more vulnerable to EMP than those of a few decades ago, as the grid transitions from an analog system to a digital system to improve efficiency. My testimony today will focus on the Department of Homeland Security's (DHS) preparations to respond to and assist recovery from a potential EMP attack, as well as touch on the joint DHS/Department of Energy (DOE) effort to review the EMP science and provide a peer-reviewed estimate of the potential risks.

The Federal Government plays an important role supporting the critical infrastructure community to manage risks from low-probability, high-consequence events, such as EMPs and severe geomagnetic disturbances (GMDs). DHS and its interagency partners will be using our unique resources built over the past decade to address the scale and degree of uncertainty associated with risks such as the ones I am here to discuss today.

The Department takes seriously the recent review and recommendations of the Government Accountability Office (GAO) on Federal efforts to address EMP risk, as well as the recommendations issued by the 2008 EMP Commission, and welcomes further cooperation with other Government agencies to ensure we are appropriately responsive on this critical topic.

BACKGROUND ON EMP

An EMP is the burst of electromagnetic radiation created, for instance, when a nuclear weapon is detonated or when a non-nuclear EMP weapon is used. EMPs can be high-frequency, similar to a flash of lightning, or low-frequency, similar to an aurora-induced phenomenon. The consequences of an EMP can range from permanent physical damage to temporary system disruptions, and can result in fires, electric shocks to people and equipment, and critical service outages.

There are two general classes of EMP of concern: (1) Nuclear sources of EMP, such as High-altitude EMP (HEMP), and (2) Non-Nuclear sources of EMP (NNEP). HEMP results from a nuclear detonation typically occurring 15 or more miles above the Earth's surface. The extent of HEMP effects depends on several factors including the altitude of the detonation, the weapon yield, and whether it was designed for EMP effects. On the ground, effects may be diminished by the electromagnetic shielding, or "hardening," of assets. A high altitude burst could blanket the entire continental United States and could cause wide-spread impacts to multiple sectors, including to lifeline sectors such as the energy and communications. HEMP threat vectors can originate from a missile, such as a sea-launched ballistic missile; a satellite asset; or a relatively low-cost balloon-borne vehicle.

Non-Nuclear EMP (NNEP) can be created by sources such as Radio Frequency Weapons or Intentional Electromagnetic Interference devices, which are designed to produce sufficient electromagnetic energy to burn out or disrupt electronic components, systems, and networks. NNEP devices can be either electrically-driven, where they create narrowband or wideband microwaves, or explosively-driven, where an explosive is used to compress a magnetic field to generate the pulse. The range of an NNEP is fairly short (typically less than 1 kilometer) and faraday casings with line filters and surge arresters can mitigate much of the EMP effects.

POTENTIAL IMPACTS ON CRITICAL INFRASTRUCTURE

In some of its forms, EMP can cause wide-spread disruption and serious damage to electronic devices and networks, including those upon which many critical infrastructures rely. There is uncertainty over the magnitude and duration of an electric power outage that may result from an EMP event due to ambiguity regarding the actual damage to electric power assets from an event. Any electric power outage resulting from an EMP event would ultimately depend upon a number of unknown factors and effects to assets that are challenging to accurately model, making it difficult to provide high-specificity information to electric system planners and system operators. These variables include characteristics such as the EMP device type, the location of the blast, the height of the blast, the yield of the blast, and design and operating parameters of the electric power system subject to the blast. Secondary effects of EMP may harm people through induced fires, electric shocks, and disruptions of transportation and critical support systems, such as those at hospitals or sites like nuclear power plants and chemical facilities.

All critical infrastructure sectors are at risk from EMP, particularly those sectors that rely heavily on communications and sensor (e.g., radar) technology, information technology, the electric grid, or that use a Supervisory Control and Data Acquisition system. The complex interconnectivity among critical infrastructure sectors means that EMP incidents that affect a single sector are likely affect other sectors—potentially resulting in additional failures.

DHS EFFORTS TO ADDRESS GAO RECOMMENDATIONS

DHS is working collaboratively, both internally and with external stakeholders, in various arenas to address the recommendations issued by GAO on this topic. DHS has been working on the topic of EMP for a number of years, and we will continue working on it in the future. An example of our previous work on the topic of EMP includes a 2010 study on "Electromagnetic Pulse (EMP) Impacts on Extra High Voltage Power Transformers" conducted by the National Infrastructure Simulation and Analysis Center for DHS.

As part of DHS's continuing commitment to this issue, there are resources across the Homeland Security enterprise engaged on this topic, including within the Federal Emergency Management Agency (FEMA), the National Protection and Programs Directorate (NPPD), and the Science and Technology Directorate (S&T). The scope of activity, as reviewed by GAO, falls into 3 areas of activity: (1) Risk assessment and analysis, (2) communication and coordination of threat information, and (3) research and development to mitigate EMP risks.

NPPD's involvement on EMP issues resides in a number of functional components including the Office of Cyber and Infrastructure Analysis (OCIA), the Office of Infrastructure Protection (IP), and the Office of Cybersecurity and Communications (CS&C). OCIA has partnered directly with the DOE's Office of Electricity Delivery and Energy Reliability to assess the impacts of EMP and Geomagnetic disturbance events on electric power assets. This study, facilitated through DHS's National Infrastructure Simulation and Analysis Center and DOE's National Laboratories, is intended to develop scientifically rigorous, peer-reviewed methods for assessing electric power asset impacts to EMP events. This study will include participation of the intelligence community, the broader interagency, the academic community, and the private sector, when possible.

The EMP study by OCIA will leverage newly-started private-sector activities that are occurring through the Electric Power Research Institute, as well as previous government investments in research which have been sponsored by DHS and DOE. The estimated completion date of this risk analysis-based study of the electric power sector is approximately mid-2017.

IP and OCIA continue to work collaboratively with the Department of Energy and the Federal Energy Regulatory Commission (FERC). As the GAO report indicates, collaboration can and should be increased with an emphasis on identification of critical infrastructure assets of the electric power sector. Once identified, this list of assets can be used to guide protection and preparedness activities at DHS and to help prioritize response and recovery actions by DOE and DHS after a large-scale event. DHS is also increasing our collaboration with DOE and FERC in the near term, including additional collaboration between staff-level subject-matter experts.

CS&C, which oversees the National Cybersecurity and Communications Integration Center (NCCIC), has been assessing the potential risks to the communications and control elements of the electric grid from EMP, as well as radio frequency weapons, solar weather, and cyber threats for several years. As part of these efforts, the NCCIC developed the "EMP Protection Guidelines for Equipment, Facilities and Data Centers" report and provided related briefings to the Continuity of Govern-

ment community and to the Communications Sector, as well as other programs and sectors, to inform the community and help mitigate EMP and radio frequency weapons threats. The previously-mentioned joint study by OCIA and DOE's Office of Electricity Delivery and Energy will seek to learn and build upon the knowledge and expertise gained from the NCCIC's previous studies on this topic.

FEMA continues to leverage the National Preparedness System to build, sustain, and deliver the capabilities needed to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk, including risks to the energy sector. The tools and processes within the National Preparedness System include, but are not limited to, plans, training, and exercises for managing a variety of risks to the Nation's infrastructure, including EMP and cyber vulnerabilities.

FEMA is also actively developing their Power Outage Incident Annex to enhance the Response and Recovery Federal Interagency Operational Plans. The Annex, developed in partnership with the Federal interagency community and the private sector, will describe the process and organizational constructs through which the Federal Government will respond to and recover from the impacts of a wide-spread disruption in the power grid from any cause.

Lastly, S&T develops near-term solutions to bridge capability gaps, and S&T has invested in multiple research programs for increasing the electric grid's resilience against solar weather hazards. Previous research investments, such as the Recovery Transformer (RecX) project, are available for private-sector risk reduction on EMP and are available to be deployed by private-sector owners and operators today.

CONCLUSION

DHS, for many years, has pursued a deeper understanding of the EMP threat, as well as its potential impacts, effective mitigation strategies, and a greater level of public awareness and readiness. These efforts have been undertaken in cooperation with other Federal agencies and private-sector owners and operators; and we are committed to continuing to expand our focus on this issue, as warranted by the risk environment.

I want to thank the committee for the invitation to speak here today and for your on-going support for our work in this area. I welcome your questions.

Mr. PERRY. Thank you, Mr. Wales.

The Chair now recognizes Mr. McClelland.

STATEMENT OF JOSEPH MC CLELLAND, DIRECTOR, OFFICE OF ENERGY INFRASTRUCTURE SECURITY, FEDERAL ENERGY REGULATORY COMMISSION, U.S. DEPARTMENT OF ENERGY

Mr. MCCLELLAND. Chairman Perry, Ranking Member Watson Coleman, and distinguished Members of the subcommittee, thank you for the privilege to appear before you today to discuss electromagnetic threats to the electric grid in the United States.

My name is Joe McClelland, and I am the director of the Office of Energy Infrastructure Security at the Federal Energy Regulatory Commission, or FERC. I am here today as a FERC staff witness, and my remarks do not necessarily represent the views of FERC or any individual commissioner.

Under section 215 of the Federal Power Act, FERC is entrusted with the responsibility to approve and enforce mandatory reliability standards for the Nation's bulk power system. These standards are developed and proposed by the North American Electric Reliability Corporation, or NERC.

Section 215 of the Federal Power Act provides a statutory foundation to develop reliability standards for the bulk power system. However, the nature of a National security threat by entities intent on attacking the United States by exploiting vulnerabilities in the electric grid using physical or cyber means stands in stark contrast to the other major reliability events that have caused regional

blackouts and reliability failures in the past. Wide-spread disruption of electric service can quickly undermine the United States Government, its military, and the economy, as well as endanger the health and safety of its citizens.

Congress took steps to address such a situation late last year. In the Fixing America's Surface Transportation Act, or FAST Act, Congress assigned notable new authority to the Department of Energy, or DOE, and FERC, among other Federal agencies.

Consistent with these requirements, FERC established our office, the Office of Energy Infrastructure Security, in late 2012 to provide a more agile and focused approach to growing cyber and physical security threats. Our office works collaboratively with industry to share information, including best practices, to help address threats from geomagnetic disturbances, GMD, or electromagnetic pulses, EMP.

Just briefly, in 2001 Congress established a commission to assess and report on the threat from EMP. In 2004 and again in 2008, the Commission issued reports on these threats.

One of the key findings in the reports was that a single EMP attack could seriously degrade or shut down a large part of the electric power grid. Depending upon the attack, significant parts of the electric infrastructure could be, "out of service for periods measured in months to a year or more."

In order to better understand and quantify the effect of EMP and GMD on the power grid, FERC, DOE, and the Department of Homeland Security sponsored a study conducted by the Oak Ridge National Laboratory in 2010. The results of the study support the general conclusion of prior studies that EMP and GMD events pose substantial risk to equipment and operation of the Nation's electric grid and, under extreme conditions, could result in major, long-term electrical outages.

Unlike EMP attacks that are dependent upon the capability and intent of an attacker, GMD disturbances are inevitable, with only the timing and magnitude subject to variability. The Oak Ridge study assessed a solar storm that occurred in May 1921 which has been termed a 1-in-100-year event and applied it to today's electric grid. The study concluded that such a storm could damage or destroy over 300 bulk power system transformers, interrupting service to 130 million people, with some outages lasting for a period of years.

To help address GMD and EMP threats, FERC has applied both regulatory and collaborative actions. With respect to regulatory actions, FERC has taken steps such as directing NERC to propose two reliability standards on GMD requiring new operational procedures and vulnerability assessments.

With respect to collaborative actions, FERC works closely with Federal agencies, State agencies, and industry members in many ways. In general, such collaboration has included efforts to identify key energy facilities, conduct physical and cyber threat briefings and reviews to industry, including sessions on GMD and EMP, to assist with best practices for mitigation.

Examples of such collaborative action includes FERC's participation on the SWORM—Space Weather Operations, Research, and

Mitigation—Task Force created in late 2014 by the National Science and Technology Council.

In addition, as required by the FAST Act, DOE, in consultation with FERC and others, is developing a plan to establish a strategic transformer reserve. Specific to the subject of today's hearing, the strategic transformer reserve plan will identify ways to decrease vulnerabilities from physical and cyber threats, including both EMP and GMD.

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

[The prepared statement of Mr. McClelland follows:]

PREPARED STATEMENT OF JOSEPH MCCLELLAND

MAY 17, 2016

Chairman Perry, Ranking Member Watson Coleman and Members of the subcommittee: Thank you for the privilege to appear before you today to discuss electromagnetic threats to the electric grid in the United States. My name is Joe McClelland and I am the director of the Federal Energy Regulatory Commission's Office of Energy Infrastructure Security (OEIS). I am here today as a Commission staff witness, and my remarks do not necessarily represent the views of the Commission or any individual Commissioner.

In the Energy Policy Act of 2005, Congress entrusted the Commission with a major new responsibility to approve and enforce mandatory reliability standards for the Nation's bulk power system. This authority is in section 215 of the Federal Power Act. It is important to note that FERC's jurisdiction and reliability authority under section 215 is limited to the "bulk power system," as defined in the FPA, which excludes Alaska and Hawaii, as well as local distribution systems. Under the section 215 authority, FERC cannot author or modify reliability standards, but must depend upon an Electric Reliability Organization (ERO) to perform this task. The Commission certified the North American Electric Reliability Corporation (NERC) as the ERO. The ERO develops and proposes for the Commission's review reliability standards or modifications, which the Commission can either approve or remand. If the Commission approves a proposed reliability standard, it becomes mandatory in the United States and is applicable to the users, owners, and operators of the bulk power system. If the Commission remands a proposed standard, it is sent back to the ERO for further consideration. The Commission is required to give "due weight" to the technical expertise of the ERO when reviewing any of NERC's proposed standards.

Section 215 of the Federal Power Act provides a statutory foundation for the ERO to develop reliability standards for the bulk power system. However, the nature of a National security threat by entities intent on attacking the United States by exploiting vulnerabilities in its electric grid using physical or cyber means stands in stark contrast to other major reliability events that have caused regional blackouts and reliability failures in the past, such as events caused by tree-trimming practices. Wide-spread disruption of electric service can quickly undermine the U.S. Government, its military, and the economy, as well as endanger the health and safety of millions of citizens.

I note that Congress took steps to address such a situation late last year, including in the Fixing America's Surface Transportation Act (FAST Act) a section entitled, "Critical Electric Infrastructure Security." That section assigned notable new authority to the Department of Energy (DOE) and the Commission, among other Federal agencies. Under this new authority, DOE can declare a grid security emergency and order actions to address it. As I will discuss further below, DOE is also to consult with the Commission regarding development of a Strategic Transformer Reserve Plan to reduce the threats from physical, cyber, EMP, GMD, severe weather, and seismic events. The Commission, in consultation with DOE, is to develop regulations governing the designation, protection, and appropriate sharing of Critical Electric Infrastructure Information. In addition, under the Cybersecurity Act of 2015 also enacted late last year, Congress directed the Federal Government to share and receive cybersecurity threat and mitigation information, while restricting its regulatory use, with non-Federal entities including State governments and industry.

Consistent with these requirements, the Commission established OEIS in late 2012 to provide a more agile and focused approach to growing cyber and physical

security threats. The mission of OEIS is to provide expertise and assistance to the Commission, other Federal and State agencies and jurisdictional entities in identifying, communicating, and seeking comprehensive solutions to significant potential cyber and physical security risks to the energy infrastructure under the Commission's jurisdiction. This includes threats from geomagnetic disturbances (GMDs) and electromagnetic pulses (EMPs).

Specific to the subject of this hearing, GMD and EMP events are generated from either naturally-occurring or man-made causes. 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. Regarding man-made events, 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. In the case of the former, equipment is readily 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. The EMP generated during the detonation of a nuclear device is far more encompassing and generates 3 distinct effects, each impacting different types of equipment; a short high-energy RF-type burst called E1 that destroys electronics; a slightly longer burst that is similar to lightning termed E2; and a final effect termed E3 that is similar in character and effect to GMD targeting the same equipment including key transformers. Any of these effects can cause voltage problems and instability on the electric grid, which can lead to wide-area blackouts.

In 2001, Congress established a commission to assess and report on the threat from EMP. In 2004 and again in 2008, that commission issued reports on these threats. One of the key findings in the reports was that a single EMP attack could seriously degrade or shut down a large part of the electric power grid. Depending upon the attack, significant parts of the electric infrastructure could be "out of service for periods measured in months to a year or more." It is important to note that effective mitigation against solar geomagnetic disturbances and non-nuclear EMP weaponry can also provide an effective mitigation against the impacts of a high-altitude nuclear detonation.

In order to better understand and quantify the effect of EMP and GMD on the power grid, the Commission, DOE, and the Department of Homeland Security (DHS) sponsored a study conducted by the Oak Ridge National Laboratory in 2010. The results of the study support the general conclusion of prior studies that EMP and GMD events pose substantial risk to equipment and operation of the Nation's electric grid and under extreme conditions could result in major long-term electrical outages. Unlike EMP attacks that are dependent upon the capability and intent of an attacker, GMD disturbances are inevitable with only the timing and magnitude subject to variability. The Oak Ridge study assessed a solar storm that occurred in May 1921, which has been termed a 1-in-100-year event, and applied it to today's electric grid. The study concluded that such a storm could damage or destroy over 300 bulk power system transformers interrupting service to 130 million people with some outages lasting for a period of years.

To date, a few U.S. entities have taken some initial steps to address EMP on their systems, but much work remains. Internationally, the United Kingdom, Norway, Sweden, Finland, Germany, South Korea, Japan, Australia, New Zealand, South Africa, Israel, and Saudi Arabia have GMD and/or EMP programs in place or are in the early stages of addressing or examining the impacts of GMD or EMP. The costs of these initiatives can vary widely depending on factors such as the threshold of protection, the service requirements of the load, the type of equipment that is to be protected, and whether the installation is new or a retrofit.

With these issues and challenges in mind, the Commission has used a two-fold approach to help address the GMD and EMP threats, applying both regulatory and collaborative actions.

First, with respect to regulatory actions, the Commission has directed NERC to propose 2 reliability standards on GMD. The Commission approved the first of NERC's proposals, a mandatory reliability standard that requires certain entities to implement operational procedures to mitigate the effects of GMD events. The Commission also has issued an order proposing to approve the second of NERC's proposals, a reliability standard that would establish requirements for certain entities to conduct initial and on-going assessments of the vulnerability of their transmission systems against a benchmark geomagnetic disturbance. The Commission has received comments on its proposed order and held a related technical conference in March. The Commission is currently reviewing this record to determine how to move forward.

The Commission's regulatory authority with respect to rates also may be relevant to addressing these issues. For example, the Commission has issued 2 orders to provide clarity on how it will address services provided by Grid Assurance, a company recently created by several electric utilities and energy companies. Grid Assurance is intended to enhance grid resilience and protect customers from prolonged outages by providing electric utilities that subscribe to Grid Assurance with timely access to an inventory of emergency spare transmission equipment, including transformers, that otherwise can take months or longer to acquire.

Second, with respect to collaborative actions, the Commission works closely with Federal agencies, State agencies, and industry members in many ways. In general, such collaboration has included efforts to identify key energy facilities; conduct physical and cyber threat briefings, including on GMD and EMP, to industry members; assist with the 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.

Some of the Commission's collaborative actions are relevant to GMD and EMP threats. For example, in November 2014, the National Science and Technology Council (NSTC) 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. This Task Force is co-chaired by members from the Office of Science and Technology Policy, DHS, and the National Oceanic and Atmospheric Administration. The Commission has participated in the SWORM Task Force's efforts from its inception.

In addition, as required by the FAST Act, DOE, in consultation with the Commission and others, is developing a plan to establish a Strategic Transformer Reserve. The Strategic Transformer Reserve Plan is to identify the sufficient number, type, cost, and location of equipment needed to temporarily replace critically-damaged large power transformers and substations that are part of the critical electric infrastructure or that serve defense and military installations. Specific to the subject of today's hearing, the Strategic Transformer Reserve Plan will decrease vulnerabilities related to physical and cyber threats, including both EMP and GMD. The Strategic Transformer Reserve Plan is not limited to transformers, but is also to include other critical electric grid equipment as necessary to provide or restore sufficient resiliency.

The Commission's efforts to date are consistent with the recommendations of the Government Accountability Office's recently-released report on electromagnetic risks to the electric grid. I believe that building on previous collaboration among the Commission and other Federal agencies can enhance our collective response in addressing electromagnetic threats to the electric grid in the United States.

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

Mr. PERRY. Thank you, Mr. McClelland.

The Chair now recognizes Mr. Freed for his statement.

STATEMENT OF JUDSON M. FREED, DIRECTOR, EMERGENCY MANAGEMENT AND HOMELAND SECURITY, RAMSEY COUNTY, MINNESOTA, ON BEHALF OF THE NATIONAL ASSOCIATION OF COUNTIES

Mr. FREED. Thank you, Chairman Perry, Ranking Member Watson Coleman, and Members of the subcommittee, for this opportunity to testify today on Federal efforts addressing electromagnetic risks.

My name is Judson Freed, and I serve as director of emergency management and homeland security in Ramsey County, Minnesota. I also serve the justice and public safety committee of the National Association of Counties, which represents all of America's 3,069 counties, parishes, and boroughs.

As a large urban county located in the northern Midwest, Ramsey County faces perennial threats ranging from tornadoes and ice storms to train derailments and multi-location terrorist attacks. In my role as the county's emergency management director and homeland security director, I work to protect our local commu-

nities and their residents and their structures from the on-going threats posed by these and other disasters.

Although all parts of government play a role in disasters, counties across the Nation often serve as the first line of defense before and after disaster strikes, and we are responsible for helping our communities recover in the aftermath. Any potential failing of our Nation's power grid and the cascading impacts that would follow would heavily impact local governments and require an immediate on-the-ground response by county emergency managers and a range of other local officials.

With that said, Mr. Chairman, I respectfully submit 3 principles for your consideration as you assess Federal efforts to mitigate against electromagnetic risks.

First, the impact of Federal policy changes on local government should be closely considered, particularly when it comes to matters of emergency management. Local governments respond to the Federal Government's actions not just in our role as intergovernmental partners with Federal agencies but also because our constituents demand that their local leaders keep pace with the Federal Government's priorities and initiatives.

Federal policy changes related to electromagnetic risks would impact local emergency management efforts. Consider the Critical Infrastructure Protection Act. The bill would require in part that the DHS Secretary conduct outreach to educate emergency response providers at all levels of government of the threat of electromagnetic pulse events. Requirements like this can accumulate quickly and have the potential to disrupt the on-going process of local emergency management planning and coordination.

Second, electromagnetic risks should be viewed in the context of the whole wide variety of threats faced by our Nation and its local communities. Due to changes in things like weather patterns and population growth, especially in densely-populated areas like Ramsey County, our Nation is facing an arguably unprecedented number of threats and disasters. According to NACo's analysis of data made available by FEMA, 92 percent of counties across the Nation have had at least 1 Presidential disaster declaration in the last 10 years.

Further, due to globalization and advances in technology that have made us more interconnected than ever before, communities across the country also face novel cybersecurity threats from within and outside of the United States. We urge you to consider electromagnetic threats in the context of the full range of risks faced by our communities.

Last, emergency management resources, both fiscal and administrative, are finite at all levels of government and should be allocated based on holistic and pragmatic risk assessment. Diverting limited resources from highly probable threats will make our Nation less prepared for the risks and disasters that have proven to be perennial visitors to all of our communities.

In Ramsey County, we have worked hard to ensure that our emergency management decisions and policies are based on pragmatic and scientific risk assessment that takes into consideration both the potential consequences and the likelihood of various threats. This method of emergency management risk assessment is

one that was promoted in the 2014 Homeland Security QHSR and is widely accepted as a local best practice in counties Nation-wide.

That said, we are by no means inattentive to the threats posed to our power grids. In my county, for example, we monitor space weather and provide weekly reports to our local public safety partners and leadership. We monitor the status of our region's power grid and include our utility providers in our oversight and planning workgroups.

We assess transmission line protection in light of severe weather and flooding, as well as geomagnetic incidents, and large-scale power failures would present significant and cascading challenges to our emergency response systems. We consider these risks in our disaster response and coordination efforts, and we base them on our broader risk assessment strategies and work to mitigate these risks at every opportunity.

In closing, I would like to thank you again for the opportunity to provide the local perspective in this important conversation on Federal efforts to address electromagnetic risks, and I will welcome any questions you may have.

[The prepared statement of Mr. Freed follows:]

PREPARED STATEMENT OF JUDSON M. FREED

MAY 17, 2016

Thank you Chairman Perry, Ranking Member Watson Coleman, and Members of the Subcommittee on Oversight and Management Efficiency for this opportunity to testify.

My name is Judson Freed and I have served as director of emergency management and homeland security in Ramsey County, Minnesota since 2003. I am also vice chair of the Emergency Management Subcommittee of the National Association of Counties' Justice and Public Safety Policy Steering Committee.

ABOUT NACO

NACo is the only national organization that represents county governments in the United States, including Alaska's boroughs and Louisiana's parishes. Founded in 1935, NACo assists America's 3,069 counties in pursuing excellence in public service to produce healthy, vibrant, safe, and resilient communities.

ABOUT AMERICA'S COUNTIES

Counties are highly diverse, not only in my State of Minnesota, but across the Nation, and vary immensely in natural resources, social and political systems, cultural, economic and structural circumstances, and public health and environmental responsibilities. If you've seen 1 county, you've seen 1 county, and there are 3,068 more to go.

Counties also often serve as our Nation's first line of defense before and after disasters strike. While State statutes and organizational structures vary, local emergency management responsibilities are most commonly vested in county governments. Many counties, including Ramsey County, are required to maintain an emergency management agency to coordinate all activities related to emergency and disaster situations. These responsibilities go well beyond the functions of public safety and emergency services and involve a community-wide effort before, during, and after a disaster or emergency incident occurs. Emergency managers are charged with preparing their communities for disasters so that when these events inevitably take place, their toll on our residents, homes, and public and private structures is minimized. Following a disaster, local emergency managers, on behalf of their elected officials, work to mitigate damage and save lives. In the aftermath of disasters, we coordinate and help fund clean-up, recovery, and rebuilding so that our residents can return to their lives as quickly as possible.

ABOUT RAMSEY COUNTY, MINNESOTA

Ramsey County is a large, fully urban county located near Minnesota's border with Wisconsin, and with a population of more than 550,000, is the second-most populous county in Minnesota. It is also the smallest county in Minnesota, and with its large population, among the most densely populated counties in the Nation. St. Paul, the capital of Minnesota, is our county seat.

As a large, urban county located in the northern Midwest, Ramsey County faces perennial threats ranging from tornadoes and ice storms to train derailments and multi-location terrorist attacks. In my role as the county's director of emergency management and homeland security, I work to protect our local communities and their residents and structures from the on-going threats posed by these disasters.

FEDERAL EFFORTS TO ADDRESS ELECTROMAGNETIC RISKS: THE LOCAL PERSPECTIVE

Counties are not merely stakeholders in this conversation, but a pivotal part of the Federal-State-local partnership of governments that together share the responsibility of protecting our Nation and its residents from disasters. Any potential failing of our Nation's power grid—and the cascading impacts that would follow—would require an immediate on-the-ground response by county emergency managers, law enforcement, firefighters, EMS, 9–1–1 call centers, public health officials, and public records and code inspectors. As such, counties appreciate the potential threat posed by electromagnetic risks and commend the subcommittee for convening this hearing to assess Federal efforts to address these risks.

Mr. Chairman, I will focus my remarks today on 3 principles that we believe the subcommittee should observe as you assess Federal efforts to mitigate against electromagnetic risks:

- First, the potential impact of Federal policy changes on local governments should be closely considered, particularly when it comes to emergency management. Counties are charged with protecting local communities from threats both natural and man-made, and Federal actions that change National priorities can unintentionally compromise counties' ability to carry out this responsibility and ultimately make our Nation less safe.
- Second, electromagnetic risks should be viewed in the context of the wide variety of threats faced by our Nation and its local communities. We must prepare for an arguably unprecedented variety of risks—from hurricanes and tornadoes to terrorism and cybersecurity threats—and should not lose sight of this fact as we assess electromagnetic threats.
- Third, emergency management resources—both fiscal and administrative—are finite at all levels of government and should be allocated based on holistic and pragmatic risk assessment. Diverting limited resources from highly-probable threats will make our Nation less prepared for the risks and disasters that have proven to be perennial visitors to our communities.

By observing these principles—which are elaborated upon below—as you assess Federal efforts to mitigate against electromagnetic risks, the subcommittee can lessen the likelihood that policy changes made leave our country more prepared for one particular threat while decreasing our overall preparedness for the many different risks that face our local communities at any given time.

The potential impact of Federal policy changes on local governments should be closely considered, particularly when it comes to emergency management..—As outlined in the opening section, counties play a critical role in protecting our local communities from natural and man-made threats. It has been said that "disasters are local," and I can attest that a well-organized local emergency management structure is crucial to disaster preparation, mitigation, and recovery efforts.

But many factors affect a local emergency manager's ability to perform his or her functions in a streamlined and efficient manner. De-prioritization of emergency management efforts at the county level or insufficient support for emergency management from the State government are just 2 examples. Another example—most relevant to the conversation at hand—involves rapidly-changing priorities and policies at the Federal level. Counties respond to the Federal Government's actions, not just in our role as intergovernmental partners working with our Federal counterparts towards the shared goal of serving American residents, but also because our constituents demand that their local leaders keep pace with the Federal Government's priorities and initiatives.

Policy changes related to electromagnetic risks would be no different in this regard. Consider the Critical Infrastructure Protection Act (H.R. 1073), which was passed by the House late last year. The bill would require, in part, that the Secretary of the U.S. Department of Homeland Security "conduct outreach to educate . . . emergency response providers at all levels of government of the threat

of [electromagnetic pulse] events." Imposing Federal requirements like this has the potential to disrupt the on-going process of local emergency management planning and coordination and could undermine our ability to preserve the safety of our communities. We urge Members to consider the cumulative impact of such requirements as Congress works to enact this legislation.

Electromagnetic risks should be viewed in the context of the wide variety of threats faced by our Nation and its local communities.—Due to changes in weather patterns and population growth—especially in densely-populated areas like Ramsey County—our Nation is facing an arguably unprecedented number of threats and disasters. We must not lose sight of these various threats as we take on the work of assessing the risks posed by electromagnetic pulses and space weather events.

According to NACo's analysis of data made available by the Federal Emergency Management Agency (FEMA), 92 percent of counties across the Nation have had at least one Presidential disaster declaration in the past 10 years. Overall, these disaster declarations are happening at unprecedented rates, and each disaster seems costlier than the last. Due to globalization and advances in technology that have made us more interconnected than ever before, communities across the country also face novel cybersecurity threats from within and outside the United States.

While we appreciate the importance of protecting our Nation against a potentially devastating failure of our power grids resulting from an electromagnetic event, we urge you to consider this threat in the context of all of the risks and threats that we have been entrusted to protect our communities against, especially at a time when the full range of threats seems to be increasing year after year.

Emergency management resources—both fiscal and administrative—are finite at all levels of government and should be allocated based on holistic and pragmatic risk-assessment.—As disasters increase in both frequency and cost, we must be pragmatic in resource allocation, so that our limited emergency management resources go as far as possible in preserving lives, homes, and public and private structures in our local communities. Rather than creating new priorities or costly mandates, we urge you to view electromagnetic risks as one element in the portfolio of major risks we face.

In Ramsey County, we have worked hard to ensure that our emergency management decisions and policies are based on pragmatic risk assessment that takes into consideration both the likelihood and potential consequences of various threats. This method of emergency management is one that was promoted in the United States. Department of Homeland Security's 2014 Quadrennial Homeland Security Review, and is widely accepted as a local best practice in counties throughout the country. Through this sort of risk assessment, we aim to make resource allocation decisions that will best protect our communities from threats and disasters. While low-priority events like electromagnetic pulses may be deprioritized in this way—and while we appreciate that these events are not unprecedented—we nonetheless believe that given our finite resources, we can best protect our residents, homes, and public and private structures through this manner of risk assessment.

That said, we are by no means inattentive to the threats posed to our power grids. We monitor space weather reports and provide weekly reports to our public safety partners and leadership; we monitor the status of our region's power grid and include our utility providers in our oversight and planning workgroups. We assess transmission line protection in light of severe weather and flooding—as well as geomagnetic incidents. Whether through space weather, terrorist threat, or an ice storm or hurricane, large-scale power failures would present significant and cascading challenges to our emergency response systems, and we consider these risks in our disaster response and coordination efforts, and based on our broader risk-assessment strategies, work to mitigate these risks at every opportunity.

CLOSING

Thank you again Chairman Perry, Ranking Member Watson Coleman, and Members of the subcommittee for this opportunity to provide the local perspective in this important conversation on Federal efforts to address electromagnetic risks.

Mr. PERRY. Thank you, Mr. Freed.

The Chair now recognizes himself for a few minutes of questioning. I am going to start out with Mr. McClelland from FERC.

Sir, given that FERC liaisons with industry frequently, please provide the subcommittee with the industry perspective as you see it on the threat posed by EMP. For example, does industry feel

they are well-prepared for an EMP event? Or do you think they are?

Mr. MCCLELLAND. So that is a tough question to start.

At this point, industry has been requesting better intelligence regarding the probability of an EMP strike. There isn't much doubt as far as the science behind the strike, what could happen to the power grid in the event that a strike occurs.

The question from industry's perspective is, how do we rank this risk? How do we prioritize this assignment from the Federal Government? What is the probability that we will see a nation-state attack, a high-altitude electromagnetic pulse from a nuclear warhead?

To follow up, because of that, there's been very little done by industry to prepare for this attack.

Mr. PERRY. Okay. Thank you.

I am going to move on to Mr. Currie.

How has the lack of a lead DHS office or official responsible for EMP impacted DHS's efforts? Has this led to inefficiencies or duplication? Can you enumerate?

Mr. CURRIE. Sure.

We didn't actually find any instances of duplication across the departments, but what we said in our report was that, certainly, because of the lack of a coordination lead, there is higher risk of potential overlap, fragmentation, and duplication.

I don't think we really know, because there hasn't been a cross-departmental coordination effort to look at all the research that has been done, all the testing and development that has been done as part of a holistic plan. So we really don't know.

But the lack of a lead, I think, has just led to a lot of confusion, especially in industry, as well, about who is responsible for this and what they are supposed to be doing to address it. Mr. McClelland hit that point. It is, who are we supposed to go to, to understand these risks, and who are we supposed to go to to understand the research behind how we protect against these risks?

Mr. PERRY. But you said that you don't know that it has led to any inefficiency or duplication? I just want to make sure I understand you.

Mr. CURRIE. Yeah, we did not find—we looked across all the Departmental efforts—and, actually, I just want to say that, when you go talk to the Department about these issues, they don't have a list of EMP or electromagnetic actions. What we did is we looked across all the actions they were taking to protect critical infrastructure for the energy sector and we said, well, how does this apply to EMP and the EMP Commission? So we actually did that work.

We didn't find duplication of effort, but what we found is little coordination between the departments of those efforts.

Mr. PERRY. Okay.

You are still, obviously, recommending that there should be a lead, one individual that is the go-to person that is coordinating the effort where the buck stops, right?

Mr. CURRIE. Absolutely. Within DHS, it is critical, I think, that there be a stop within DHS. We actually found in DOE and FERC that it was pretty clear who was responsible for this, just not within DHS.

Mr. PERRY. Okay. Thank you.

Mr. Wales, an EMP attack can be carried out by detonating a nuclear device above the atmosphere or through the use of EMP weapons. If you know, what nations and/or hostile nation-states or actors currently have the capability to launch such an attack? What steps is DHS taking to specifically protect critical infrastructure from an EMP attack?

Mr. WALES. Sure. Thank you, sir.

So any country that has a nuclear capability would have the capacity to generate an electromagnetic pulse from the explosion of a nuclear weapon.

With that being said, the Department relies heavily on the expertise of the broader U.S. intelligence community to provide us information on the capabilities and intent of our potential adversaries. In an open hearing, I don't think I am comfortable sharing the kind of information that they have provided to us in the past.

But I will say that we are guided by the consensus view of the intelligence community as enumerated in the report released in 2014 on the threat posed by a high-altitude EMP event against the United States over the next 5 years.

Mr. PERRY. Let me just ask you, the steps that DHS is taking specifically to protect critical infrastructure, even if they are just recommendations for best practices, have you seen them? Do they seem adequate and appropriate to you?

Mr. WALES. The question of whether the grid can withstand a large electromagnetic pulse today, I mean, clearly the answer is no. We are not prepared for that type of significant attack.

I think that being said, industry does work to try to improve its overall level of resilience. The Department has, I think as I outlined in my testimony, provided information to help them make better decisions. Obviously, as outlined by GAO, there is more to be done, and we are committed to executing on GAO's recommendations. We think that will further help industry be prepared.

But, ultimately, given the current authority at the Department and DOE and elsewhere, the ultimate burden for preparing for that type of event on the systems that operate our grid are going to be the utilities themselves. The work that we do is to help them be as prepared as they can be by providing them the kind of information that can help them make better decisions.

Mr. PERRY. Okay. Thank you.

My time has expired. The Chair now recognizes the gentlelady, Mrs. Watson Coleman.

Mrs. WATSON COLEMAN. Thank you very much, Mr. Chairman.

Mr. Currie, you indicated that you think that Homeland Security should be sort-of the coordinating agent, there should be someone there that is the go-to person for this whole issue. What component do you think should have that responsibility?

Mr. CURRIE. So we didn't actually designate in the report who we thought it should be.

I will tell you that, in law and Presidential Directive, it is pretty clear that NPPD, Mr. Wales' parent organization, is responsible for critical infrastructure protection.

That was one of the key points in our report, is even though they didn't have to implement the Commission's recommendations—and, by the way, one of the Commission's recommendations was to establish roles and responsibilities and make that clear—they are already responsible for doing that under the National Infrastructure Protection Plan. So it would likely be in NPPD.

Mrs. WATSON COLEMAN. Okay. Thank you.

Mr. Freed, as emergency management director, you are aware of a range of natural occurrences and threats impacting the homeland, in particular in your county. Please state the threats, the dangers, or the occurrences that are of specific concern in your district. Share with us, please, how does the EMP risk fit into this in the priority of areas?

Mr. FREED. Thank you for that question.

Under the methodology that DHS has worked to help us go forward on our risk assessment, we take a look at the various bad things that can happen in our county, their likelihood and impact, our capabilities to cope with those, and then basically look at the gaps between capability and worst case. We concentrate on worst-case, most-plausible events, and then go forward from there to kind-of develop the things that keep us up at night.

We don't actually rank them, but there is sort-of the big group that does. Among that big group, of course, in the upper Midwest, you can imagine, tornados; you can imagine, winter storms. But prolonged power failure, particularly during the wintertime in the upper Midwest, is 1 of our 3 very big events. There is also hazardous materials incidents and terrorist attack are things that in urban areas such as ours we worry about.

The impacts of a power failure, however, are the impacts of a power failure whether it is caused by a high-altitude EMP, a geomagnetic disturbance, an ice storm bringing down the power lines. If there is a surge that destroys one of those EHV transformers, we are going to rely on the transformer stockpile or some other method.

So I certainly don't want to discount the absolute importance of the EMP and GMD preparedness; I just want to ask the committee to keep in mind that, you know, we need to address these things holistically. Preparing to cope with the threat to an EHV transformer, we can do that without increasing rules, regulations, training requirements for local government officials to make them all experts at E1, E2, and E3 effects of HEMP. I mean, that is sort-of where we look at it, is more holistically. That is, you know, our ask to the committee to consider.

Mrs. WATSON COLEMAN. So do you have a relationship with the Department of Homeland Security in sort-of discussing and developing this, sort-of, risk-based management? Tell me to what degree do you interact with the Department.

Mr. FREED. Much better in recent years than in past.

I teach—I am a risk geek——

Mrs. WATSON COLEMAN. I am sorry, I didn't hear that.

Mr. FREED. I am a risk geek. I teach risk at the collegiate level, undergraduate collegiate level. Very often, the assessment of risk is extremely superficial and inaccurate. The vulnerability-times-

consequences measure—that is TVC—it is not an effective way at looking at risk.

Through programs like the Urban Areas Security Initiative and what is called the THIRA requirement, which is a Threat and Hazard Identification and Risk Assessment, we have started to now, Nation-wide, adopt some of the risk-geekiness application of measurement. So instead of, "Well, that would be bad," we now look at why it would be bad, and what are potential causes?

The problem comes that we can't prevent all of those causes, but we can mitigate widely against those events. Wherever possible, mitigating in a manner that protects us against multiple events is sort-of the key to doing this in an effective manner and an efficient manner as well.

So that is what we try and do, is we try and take a look at those gaps and figure, if we do this training or buy this piece of equipment or implement this policy, procedure, or plan, can we cope with a lot of things or are we only protecting against one possibility?

Mrs. WATSON COLEMAN. Thank you, Mr. Freed.

My time is up. I yield back.

Mr. PERRY. The Chair thanks the gentlelady.

The Chair now recognizes the gentleman from Georgia, Mr. Loudermilk.

Mr. LOUDERMILK. Thank you, Mr. Chairman.

Thank you to all the witnesses being here today. It is a very important subject and one that, even on the Science, Space, and Technology Committee, that we have addressed some of these.

I do have some more technical questions.

Mr. Wales, when we talk about the potential of an EMP attack, what specific damage would be done to power generation? Can you address that? Or anyone? What I am looking at is what damage would be done to generation versus the distribution system?

Mr. WALES. In an EMP event, because EMP generates multiple types of waves that will affect different systems in different ways, we would expect disruption to both generation and distribution systems—generation, transmission, and distribution systems. Any system that has industrial control systems could be affected by some parts of the EMP event. The transmission lines could be affected by others.

The scale will obviously depend upon the unique type of what is generating the EMP pulse, where it is, how it is detonated—ground, air, et cetera. So there are a lot of factors.

In part, this is why we have launched this new project with the Department of Energy to better bound what types of EMP events are going to potentially create the most amount of damage to the power systems and which ones are likely to generate less impacts.

Obviously, the thing that we are concerned about most would be permanent damage to large equipment like the high-voltage transformers that have much longer lead times for replacement and are often built for specific purposes.

Mr. LOUDERMILK. Okay. That is kind-of what I was getting at. I have heard several of you talk about these transformers, and stockpiling these transformers. But in case of an EMP attack on the United States, is predominantly the damage to the power gen-

eration going to be done in the microprocessors, the control systems? Or are we actually looking at the generators itself being fried, for lack of a more technical term?

Mr. WALES. I think the issue would be more of a concern with the transmission substation being——

Mr. LOUDERMILK. Okay. So hydroelectric dams, coal power facilities would still be able to generate power, it is just they wouldn't be able to——

Mr. WALES. Possibly. Those would also be affected by the loss of their control systems from microprocessor disruptions from an EMP event.

But I think the—we have a lot more generation in the country. We have a lot of excess generation that can be spooled up when we need it, and a lot of it is not on-line at any given moment. Therefore, the bigger concern is the transmission disruptions, the substations that could be damaged through an EMP.

Mr. LOUDERMILK. Okay.

Then my concern is around the protection of those replacement parts, per se. Is there a method of protecting—are we protecting, let's say, the transformers that we talked about? Stockpiling the transformers? What type of protection do we have to ensure that even those would not be damaged?

Mr. WALES. So there is a small amount of extra transformers that are maintained by industry, and they have a program to share those in the midst of a disruption. That is obviously meant for smaller-scale disruptions. They can get those in place. At times, utilities will also maintain an extra spare on site that may not be activated at any given moment that could be brought back up on line.

But this is also why the Department invested in this recovery transformer project through our Science and Technology Directorate that actually piloted a modular transformer that can be moved in and gotten up and running more quickly than traditional transformers. That project successfully demonstrated that that could be done with the Houston CenterPoint utility back in 2014. That was a project that was worked jointly with industry. So that demonstration project is now available should industry want to purchase transformers like those that can be brought up on-line very quickly and more——

Mr. LOUDERMILK. Those could be protected if they are not actively on the grid?

Mr. WALES. Correct. Generally, if a system is not in use, it has a much higher degree of surviving an electromagnetic pulse.

Mr. LOUDERMILK. Okay.

You mentioned the 1920s geomagnetic disturbance. Would something like that, if it were to happen today, have a world-wide effect? Or would it be more limited to, what position the Earth was in, those that were facing the sun at the moment it happened?

Mr. WALES. There are going to be some effects that may be global. So, as it scintillates satellites, it could affect multiple parts of our constellations. Depending on the length and intensity of a geomagnetic event, it could have wider-scale impacts.

In general, I think the specifics of a geomagnetic event are going to determine the effect it has both on the country and any of our

neighbors. In general, we assume that the higher latitudes are going to be more directly affected than lower latitudes, but it also will depend upon things like the geology of those areas, how much they will carry geomagnetic effects.

So these are some of the factors that need to be evaluated when trying to understand the impacts of a geomagnetic event on a country.

Mr. LOUDERMILK. Okay. Thank you.

Mr. Chairman, may I just add in closing that a Congressional investigation on the attack of Pearl Harbor determined that the Government felt that the Japanese attacking Pearl Harbor was possible but not probable. The same with the 9/11 attacks, that the terrorists hijacking aircraft and flying them into Government buildings and buildings in the United States was possible but was not probable.

Mr. PERRY. The Chair thanks the gentleman.

The Chair now recognizes the gentlelady from California, Mrs. Torres.

Mrs. TORRES. Thank you, Mr. Chairman.

I have a question for Director McClelland.

National electrical systems for countries across the globe are structured in many different ways. Mitigation for geomagnetic disturbances will have to be tailored to specific countries' needs.

Are you aware of any plans to propose international standards, given that there are so many different and individualized systems that will need specialized mitigation?

Who would oversee such an effort? I am trying to understand this issue. Is this an issue unique to the United States, or is this an issue that we should be working with our partners across the world?

Mr. MCCLELLAND. Thank you for the question.

Currently, there are many independent initiatives internationally. So the United Kingdom, Norway, Quebec have all initiated, not to mention other countries as named in the—there is a Congressional research report for Congress in, I will say, March 26, 2008, that specifically mentions mitigation efforts in, for instance, Russia from both GMD and EMP.

So, independently, these nations are moving forward. They are protecting the most critical—they are identifying and prioritizing infrastructure, energy infrastructure, to protect their population, and they are moving forward with mitigation efforts.

To date, the United States has coordinated and has shared information with other nations, but there is no international standards development and nothing compulsory that is being shared across the nations. But, as I said, the United States is falling behind. Other nations are moving ahead for mitigation on geomagnetic disturbances and, in some cases, electromagnetic pulse.

Mrs. TORRES. So, back to my question, who do you think should oversee those efforts? Is that something that the United States solely should continue to pursue? Or is that something that should fall under U.N.-specific standards? Should there be a specific commission related to this issue? How broad is it and how much of a global impact, given our trade agreements and all of that that could impact our communities across the world?

Mr. MCCLELLAND. I do think international collaboration will be important. I think that the large storms—1859, 1921—they occurred over a period of days, so the entire Earth was affected by these storms, but no one had the interconnectedness of the power grids that they have today and, arguably, the vulnerability of the equipment.

Traditionally, it has not been FERC. FERC is not an agency that works across those lines internationally. It would be the Department of Energy and the Department of Homeland Security. So I would defer to my colleague from the Department of Homeland Security to better describe what could be done internationally.

Mr. WALES. DHS works on a number of issues collaboratively with international partners related to terrorism, cyber threats. I don't think in any of those are we attempting to organize the international community in terms of a leadership role in taking certain action. But I think, as Joe indicated, our goal is to build collaborative ties with those countries, share information, and to make sure that, to the extent possible, we are implementing good, consistent actions.

I would say it is a little bit different in the case of Canada, where we have, obviously, a shared electric power grid. There is far more collaboration there in attempting to implement pretty joint activities associated with power grid security and resilience.

Mrs. TORRES. Okay. Thank you.

Also, the electric grid doesn't produce energy out of thin air. We all know that the electric sector is highly dependent on telecommunications, especially fuel supply and delivery infrastructure. These key independencies must be identified, understood, and prioritized.

How would you prioritize fuel supply and delivery security as opposed to other infrastructure priorities? I don't know if Mr. McClelland could answer that or if that would be——

Mr. WALES. I will help out Joe here.

Mr. MCCLELLAND. Thank you.

Mr. WALES. I don't know that you can segment out some of those critical dependencies and interdependencies amongst infrastructure such as power generation, natural gas/petroleum movement, you know, communications, transportation. In many cases, you need all of them working together to successfully deliver the critical services that they provide to the American people, our economy, and our way of life.

In many cases, when we are looking at the aftermath of a major disruption or major disaster, a Hurricane Sandy, we are trying to figure out how best to get most of those capabilities up together so they can be mutually reinforcing and allow the services to continue flowing.

But I think the ones that you named are those kind of core set of lifeline services that we need and that we would prioritize in the aftermath of any type of disruption or for protection in preparedness activities.

Mrs. TORRES. Thank you, Mr. Chairman. I am out of time.

Mr. PERRY. The Chair thanks the gentlelady.

The Chair now recognizes the gentleman from Georgia, Mr. Carter.

Mr. CARTER. Thank you, Mr. Chairman.

Thank each being of you for being here. This is a very important subject, something that we are obviously all concerned about.

Mr. Wales, I will start with you. In response to the GAO's findings, DHS has responded many times that it has not taken the EMP threat seriously. Can you explain to me why it is a low priority? It would seem to me that this should be a top priority. Am I missing something here?

Mr. WALES. I would not characterize DHS's position that we are treating this as a low priority. As I think I have outlined in my statement, there is activity occurring across DHS that in some cases is directly focused on addressing EMP-related threats and their risks.

When you look at the activity that DHS co-chaired with the Office of Science and Technology Policy at the White House that developed a Space Weather Action Plan that applies across the interagency, I think that demonstrates that the Department is extremely focused on doing what it can to help improve the security and resilience against that issue.

But I would also——

Mr. CARTER. Well, now that you mention that, one of the findings in the report is there was no central entity within DHS that was concentrating on that. Have you identified a central entity yet?

Mr. WALES. So, in response to the GAO recommendations, the Department of Homeland Security identified its Office of Policy—the Cyber Infrastructure Resilience Policy Office will serve as the lead for coordinating DHS actions on EMP.

That being said, the complexity of the issue means that the various components, the operational components, of the Department need to bring to bear its specialized skills and execution to address this issue. The work that FEMA does is not going to be done by other parts of the Department. The work that S&T does to sponsor research and develop prototypes is not going to be done by other parts of the Department. The work that we do in NPPD to work with industry, conduct studies, that is not going to be done by other parts of the Department. Policy's job is to make sure that all of our efforts are aligned and moving in a common direction.

I will just say one other thing on the, kind-of, initial question, and that is, as I think has been outlined by a number of people today, we have to view EMP in terms of the broader array of risks that we face as a country in our critical infrastructure. When we devote resources to one topic, that means that we are sacrificing focus and attention on other topics.

Mr. CARTER. We understand that. We certainly understand that. But, again, it just seems that the Department is making this a low priority when it would appear to us that it needs to be a high priority and a top priority.

Let me ask Mr. McClelland.

Mr. McClelland, what changes would you suggest to be made immediately? I mean, if we are going to be better prepared, what do we need to do immediately, not only for perhaps a man-made but even a natural disaster?

Mr. MCCLELLAND. The first order of business would be to prioritize the assets. I know that DHS has done work in that area.

With 55,000 substations across the United States, I think the argument legitimately back from industry would be, "We can't protect every one of these facilities from EMP. It is simply too difficult and it is too expensive."

However, if the assets were prioritized around functionality—for instance, what do you need to provide skeletal service to major urban areas? What facilities does DOD absolutely have to have in service in order to remain mission-ready? What might be critical infrastructure service, such as off-site service to nuclear power plants? Identify those criticalities. It won't be near 55,000 stations. It may just end up being a few hundred stations.

Then from there, provide threat briefings and critical intelligence to the owners and operators of those facilities, because the Government can't do it without them. We don't own the facilities, and we have no authority to compel them to take action.

Mr. CARTER. Understood. Understood.

Mr. MCCLELLAND. Provide intelligence, and then provide cost recovery as well as best practices to——

Mr. CARTER. Okay.

Mr. Freed, best practices. Are there any best practices out there?

Mr. FREED. Best practices specific to protection against an electromagnetic incident?

Mr. CARTER. Protection and response to a problem.

Mr. FREED. The short answer is not really, not that has been promulgated down to us at the local level, but—not specifically, I guess, rather than not really. What there are best practices are in exactly what Mr. McClelland was saying, which is prioritizing—we refer to it as CIKR, Critical Infrastructure and Key Resources—prioritizing what is energized by which power substation; how are things transmitted? Then our mitigation efforts are also—there are best practices for that, the problem being that a lot of those repairs or those mitigation efforts are extremely, extremely expensive and time-consuming. For instance, if you bury a transmission line and then something happens to it, the cost of fixing it is significantly greater. So the private industries kind-of have to weigh the chances of that transmission line failing for some reason versus the cost of fixing it when it does.

Mr. CARTER. So there are things that counties and municipalities can be doing to prepare for this?

Mr. FREED. There are things that we are currently planning around. We do not own those transmission lines either. So I live in an area that gets ice storms and severe summer storms and floods on a regular basis. That has direct impact on our power transmission systems. Working on ways to mitigate against those in general and specifically protecting those power lines is something we can and do.

Mr. CARTER. Thank you. Just one last point, Mr. Wales. I hope the Department is taking this seriously and considers this a top priority because I certainly think the impression you get and the message you get from this panel today is that we are taking it very seriously.

Thank you, Mr. Chairman. I yield back.

Mr. PERRY. The Chair thanks the gentleman.

The Chair now recognizes the gentleman from Florida, Mr. Clawson.

Mr. CLAWSON. Thank you for your time today, gentlemen.

Following along this line of questioning, let's see if my logic is right. The electrical grid and the power market is a private market in the United States: Heavy regulation, private shareholders, customers, suppliers, et cetera. Normally, in our country, when there is a technical or security issue that overlaps with the private sector—Y2K comes to mind immediately. At least a couple, 2 or 3 of you all, are old enough to remember that. I certainly do. One or 2 of you probably aren't. We didn't wait around for the Government. We were involved in fixing it for our own enterprise, and moreover, there were plenty of consulting companies and others that were involved in the fix in order to solve the problem because everybody had a profit incentive, which is normally what creates innovation and solution, as opposed to Government involvement.

So, therefore, give me a summary here. I mean, the one thing—and I missed a lot of what has gone on today because I had constituents in my office, but nonetheless, if this is a real deal—and there seems to be some debate about it—but if there is a real deal, why isn't there a real market response? Or is there a real market response, not just in terms of suppliers of product but also consultants and technical folks and all the people that would be working on this if it is the real deal? What is going on with the private sector, to anyone that would like to answer?

Mr. MCCLELLAND. I can start. There are really 2 aspects here. There is geomagnetic disturbance, which is inevitable. That is going to happen. It is just a matter of the timing of when it occurs and the magnitude that will occur. An impact from a geomagnetic disturbance has been debated. So the Commission, along the agencies, Department of Energy and Department of Homeland Security, put out a report by Oak Ridge National Lab that said that, considering the current configuration of the system, if we took a 1921 storm, the impacts would be devastating. We will see over 300 transformers that could be potentially damaged or destroyed. These have a year-long lead time, in many cases custom-built for the site that they are installed with no spares.

Mr. CLAWSON. By the way, if you have an incident, that 1-year lead time is going to go to 3 or 4.

Mr. MCCLELLAND. Correct.

Mr. CLAWSON. Because you don't have enough capacity to make that, I mean, obviously.

Mr. MCCLELLAND. You could even add to that that it is probably going to be a global event. The United States does not own or control the production facilities, so those transformers may go to the international host where the factory is first, and then if there is any left over, the United States gets on the production list.

Industry, however, conducted its own study and said that the grid would collapse before there would be problems to the transformers. There would be wide-spread blackouts, but the grid would collapse. It has been the subject of some back-and-forth through an iterative process that the Commission exercises. The bottom line conclusion, though, is even if the grid collapsed—in 1989, Quebec collapsed. It was 90 seconds; 7 million people were out of power for

9 hours. Relatively little damage, but the estimated cost for that 1 collapse was $1 billion, $1–2 billion. If we use the lower number and we put in mitigation techniques to protect against it, we could protect 2,000 transformers for an incident that was relatively minor impact. By the way, Quebec has now mitigated against geomagnetic disturbances. So, even with inevitability, there is still debate about what should be done and the costs that could be incurred, which the Commission can reimburse those costs.

On the EMP side, it is even more debatable because industry would need—they want—some sort of a risk analysis: How likely is it that some of these countries, and Brandon explained it—anyone that has nuclear capability would conceivably have an ability to propagate an EMP attack—how likely is it we are going to see this, and which facilities should we protect? The approach the Commission has used is to prioritize—along with DHS—is to prioritize those assets and, for a relatively small number of assets, encourage best practices, not pass more regulation but encourage best practices along with cost recovery to protect against these threats.

Mr. WALES. I will only add that the science of hardening things against EMP is well-known. The military has been doing it since the dawn of the nuclear age when they wanted to harden their own systems to be able to withstand EMP in the event of war with Russia, the Soviet Union. So the science is there on how to protect themselves. This is just an issue of whether it is a sufficient priority for industry to make the investment, and then what is the best way for them to fund that, since they would have to go ask permission for every State utility commission to recover the cost that it would take to put in place those mitigation measures?

Mr. CLAWSON. I guess the only thing I would say is if I am in the private sector and I have some savvy investors, I might be thinking of an innovation that puts your science that you are talking about on its head. What innovators do is they find the next iteration of a more cost-effective solution so that we don't sit around saying, "This is too expensive," right? It just seems to me that somebody is out there doing something. If this is as big a deal as you say, there has got to be some X, Y, or Z company that is doing something for profit incentive to come up with a cheaper solution.

I am out of time, so you can take me back.

Mr. PERRY. The Chair thanks the gentleman.

The Chair now recognizes our guest, Mr. Franks from Arizona.

Mr. FRANKS. Thank you, Mr. Chairman.

I especially want to express gratitude just for the privilege of being your guest here today. The Chairman has, throughout the debate here for a number of years, been a champion in this area, and I am grateful. I suppose that it is not a small thing that the Chairman, in other venues or forums, is recognized as General Perry. When we discussed our military, their response, there has never been an argument with the military. We have spent billions of dollars hardening some of our critical military assets, our critical defense assets. That is telling in my mind, because the military does depend upon the civilian grid in CONUS for about 99 percent of its electricity needs, without which, even according to their own

perspective, they cannot effect their mission. So I think that is a telling point, and I appreciate the whole panel here. A lot of very good questions.

I am encouraged. I know that this is a subject that is rather daunting. The Israelis now have begun to harden their grid. They said that this is an attractive problem. You ask them, "What does that mean?" and they say, "Well, it is an existential issue for us." I am not sure how that makes it attractive. But they said, "This is one we can fix," which is kind-of an unusual situation for them.

I am almost more encouraged about the testimony that I have heard from Mr. Currie and Mr. Wales and some of the acumen and the very learned perspective that they have brought forth because that hasn't been the case in the past. I say that with all due respect. It gives me some hope.

I think there are 2 things that are critical that we do. Other than making sure that we have properly done the research that is necessary and things of that nature going forward, I think CIPA in the Senate has a good chance of precipitating some of that research, and I hope that political considerations or gridlock does not prevent that, because if it gets a fair vote, it goes forward. But I really am truly encouraged by the testimony that I have heard today.

Of course, Mr. Chairman, I consider Joe McClelland a National treasure. He has, ever since the EMP Commission first reported to the Armed Services Committee years ago, been a lone voice in many ways, and now his voice, of course, has been confirmed in so many different ways, and I am grateful for that.

If we can do 2 things, if we can come up with a National standard at which we should harden our grid, that we can all come to the conclusion based on sound science, and then use hardware-based solutions, which is what the SHIELD Act attempts to do, I think we can disincentivize either a particular enemy or certainly protect against a natural impact. If an enemy recognizes the potential danger here, it has always been, at least historically speaking, their tendency to try to exploit that.

Yes, I agree this is a low-probability, high-impact issue, but if one just does a cursory glance at history, you realize that those are the very kinds of things that we always find regret in not finding insight to at least prepare for them, because as we are now, I think we have an open invitation to some of our worst enemies if they choose to exploit that.

So, with that, I am just going to ask one question and again express the sincerest gratitude to you, Mr. Chairman, to everyone here, and to the panel, again, for the encouraging things that I am hearing.

So, Mr. McClelland, I will ask the question to you, sir, and it has been asked in different ways. But in terms of what should be done and what is being done—that is probably the one element I would add to—right now, what do you think is being done, and where are we? Are we making progress? Are we seeing people expand their understanding of this issue?

Again, thank you, Mr. Chairman.

Mr. MCCLELLAND. Let's start with what is being done. The Commission has established threshold standards, so foundational practices for geomagnetic disturbances. They are based, though, on op-

erator actions. So that assumes 2 things: That the operators have sufficient warning—and in the case of a solar flare, it is assumed that they would have sufficient warning—to take precautions to reconfigure the power grid to cause minimal impact to the power grid itself. That depends on the operator not making an error and, again, the forecast. But that would not be sufficient for an electromagnetic pulse attack.

On the electromagnetic pulse side, more studies are being conducted by the industry. They are doing some research. They are now just starting to receive threat briefings, but very little has been done to protect the power grid and the other infrastructure against an electromagnetic pulse in the United States.

Mr. PERRY. Well, thank you, Mr. Franks.

I guess this is going to remain a work in progress. Gentlemen, we appreciate your time here today. We can see that there are some places for improvement within the context of this. In some people's minds, I imagine this is an imminent threat; in other people's minds, it is something less than that. Also, in the context that it is hard-to-tell industry, I think, to move forward when you don't have your own house in order, right? So we have got to do the best we can, whether it is FERC, whether it is the Department of Energy, whether it is Homeland Security, to make sure our ducks are in a row before we go to industry and say, "This is what we would like to see," and then help them get there one way or another. So we have got to keep all that in context. Again, I think this is just going to be a continuing issue we will have to revisit to see that the benchmarks are being met and we keep moving forward to make sure that the grid is adequately protected and we are prepared for the eventuality of the, in some cases, imminent; the naturally occurring; or the maybe not-so-imminent, the other.

With that, the Chair thanks the witnesses for their valuable testimony and the Members for their questions. Members may have some additional questions for the witnesses, and we will ask you to respond to these in writing. Pursuant to committee Rule VII(e), the hearing record will remain open for 10 days.

Without objection, the subcommittee stands adjourned.

[Whereupon, at 11:17 a.m., the subcommittee was adjourned.]

APPENDIX

QUESTIONS FROM CHAIRMAN SCOTT PERRY FOR CHRIS P. CURRIE

Question 1a. The EMP Commission made 7 recommendations related to the electric grid which were mainly focused on DHS and DOE. GAO has reported that of those 7 recommendations, DHS and DOE have taken "some action" on 4 recommendations. In what ways have DHS and DOE further addressed those 4 recommendations?

Question 1b. Do DHS and DOE intend to address the remaining 3?

Answer. It is important to note that the actions DHS and DOE have taken to address electromagnetic risks are not part of a dedicated effort to implement the EMP Commission recommendations. Through our work, we identified actions taken by both agencies that aligned with some of the recommendations. Specifically, of the 7 recommendations made by the EMP Commission related to the electric grid, some of the actions that DHS and DOE took aligned with 4 of them:

1. Conducting research to better understand the interdependencies of critical infrastructures,
2. Addressing the vulnerability of control systems to an EMP attack,
3. Identifying responsibilities for responding to an EMP attack, and
4. Utilizing industry and other governmental institutions to assure the most cost-effective outcomes—(5 of 15 subparts).

However, while some of DHS's and DOE's actions have aligned with 4 of the EMP Commission's recommendations, this does not mean that each component of these 4 recommendations has been completed. Examples of some of the actions DHS and DOE have taken include the following:

- *Developing National and regional restoration plans and assuring the availability of critical communication channels*.—DHS and DOE are in the process of developing the Power Outage Incident Annex (POIA) Plan. Although it's not finalized—(expected completion is in 2016)—the POIA is intended to provide incident-specific information regarding how the Federal Government intends to respond to and recover from a loss of power resulting from deliberate acts of terrorism or natural disasters, including an EMP or geomagnetic disturbances (GMD) event.
- *Implementing efforts outlined in the National Space Weather Strategy and Action Plan*.—DHS and DOE, among other Federal agencies, are in the process of identifying efforts and taking actions as outlined in the National Space Weather Strategy and Action Plan from October 2015. The strategy identifies goals and establishes the principles that will guide space weather efforts in both the near and long term, while the Action Plan identifies specific activities, outcomes, and time lines that the Federal Government will pursue accordingly. Specifically, the Action Plan calls for Federal agencies to establish benchmarks for space weather events and to improve protection and mitigation efforts, among other actions.
- *Conducting research on the susceptibility of transformers to geomagnetic disturbances (GMD)*.—In November 2015, DOE reported initiating a study by the Oak Ridge National Laboratory to quantify the risks associated with GMD on electric power system reliability. The study plans to identify power lines and their associated transformers within the eastern section of the power grid and to determine those that are most susceptible to the effects of GMD. DOE officials expect the study to be completed in July 2016.
- *Developing a National Transformer Strategy*.—DOE developed a draft National strategy in 2015 to reduce the risk to grid reliability posed by the loss of critical large power transformers. The draft National strategy focuses on 3 areas: (1) Understanding and mitigating current and future risks to transformers, (2) enhancing protection of transformers, and (3) ensuring transformer replacement equipment is available. It also calls upon Federal Government entities, to part-

ner with electricity operators, equipment manufacturers, and State and local authorities to develop risk assessments and modeling tools to guide their efforts and prioritize activities. As of December 2015, DOE officials reported that the strategy is undergoing review.

DHS and DOE intent to address the remaining 3 EMP Commission recommendations remains unclear. There are some indications though that issues included in the recommendations are being given consideration. For example, both departments acknowledged the importance of providing capabilities to recover rapidly from an EMP attack—which is encompassed in 1 of the 3 remaining recommendations. In addition, DOE officials also identified "black start capabilities"—the ability to restart power at a generation plant that has lost power without having to use an external energy source—as an example of how to restart energy production. This capability is also discussed in 1 of the Commission's recommendations where some action has been taken but several actions remain incomplete. DHS officials have agreed that an analysis of black start capabilities is warranted.

Question 2a. A recent Idaho National Laboratory study found that updated research and analysis on the effects of the early time pulse of an EMP event is needed. In your estimation, how much of the other existing EMP research is outdated?

Question 2b. Given that research projects can take a lot of time to complete, what steps can the Federal Government take to fill any existing knowledge gaps caused by outdated information?

Answer.

- A key knowledge gap is in understanding how an EMP will affect the U.S. electric grid. The INL report noted that most information sources about the impact of EMP E1 on electric power grids are decades-old and do not account for modern grid technologies and electronic control systems. While we have been told that the DOD and the intelligence community have updated information on the EMP threat, additional opportunities may exist to leverage EMP threat information through I&A or direct collaboration with DOD, DOE, or other intelligence sources. For example, Classified analytical products are available that address specific components of threat, such as assessment of EMP-related missile technologies, which could provide an important input regarding adversary capabilities as part of DHS's overall assessment of electromagnetic threats. Although I&A officials have direct access to these materials, neither I&A nor NPPD officials identified efforts to specifically leverage this information as part of any Department-wide risk assessment efforts. Acquiring more comprehensive information on potential EMP threats may be helpful because, as one EMP expert stated in recent testimony, there are misconceptions regarding the nature and impact of potential EMP attacks, which may have a negative effect on the ability of stakeholders to determine reasonable steps needed to protect critical infrastructure and mitigate potential impacts. Additionally, as we reported, while the NPPD Office of Infrastructure Protection conducts various assessments to identify vulnerabilities, interdependencies, and potential cascading impacts across different sectors of the Nation's critical infrastructure, these have generally not been utilized to obtain specific information about vulnerabilities or consequences related to EMP or GMD events. Given the lack of comprehensive EMP-related information on the vulnerability of and consequences to the U.S. electric grid, further R&D to understand the effects, and techniques to protect against or mitigate the effects of EMP attacks is needed. In our report, we recommended that the Secretaries of Homeland Security and of Energy engage with Federal partners and industry stakeholders to identify and implement key EMP R&D priorities.
- As we also stated in our report, a 2013 white paper developed by the Electric Power Research Institute also noted a lack of wide-spread and coordinated research and development efforts to protect the commercial electric grid against EMP attacks and mitigate their effects. The institute recommended that stakeholders define key characteristics of an EMP event—such as potential altitudes of detonation—for further study of corresponding impacts, as the lack of more specific parameters for determining potential EMP effects makes it difficult to develop applicable protective guidelines and equipment design specifications. However, according to Federal Energy Regulatory Commission officials, additional work is being done outside of the United States to further develop applicable standards and implement equipment designed to mitigate the effects of or protect against EMP risks. Given the on-going nature of this work, U.S. officials may have an opportunity to investigate how they might be able to coordinate with researchers outside the United States already conducting this work to determine if working jointly could speed the completion of this research for the benefit of both parties.

- Similarly, any proposed mitigation strategies resulting from efforts to address GMD, including the National Space Weather Action Plan, could also be reviewed to determine how effective they might be against a potential EMP attack so that fully-informed investment decisions can be made. For example, as one EMP expert noted in recent Congressional testimony, if designing protective equipment to withstand specified levels of E3 effects from an EMP attack, there may be collateral benefits for providing protection against GMD effects; however, the reverse may not be true.
- We also reported that Federal agencies should improve their efforts to identify and prioritize key research and development, including an evaluation of protective equipment intended to help mitigate the impacts of an EMP event. As we recommended in our report, Federal agencies and industry stakeholders should work together to identify and implement key EMP research and development priorities, including EMP protection and mitigation options. Coordinating their efforts can also help to better ensure that limited resources are more effectively targeted toward the highest-priority research.

QUESTIONS FROM CHAIRMAN SCOTT PERRY FOR BRANDON WALES

Question 1. According to GAO's report, actions are underway to establish a Cyber, Infrastructure, and Resiliency group within the Office of Policy. How will this group differ from other offices, such as NPPD's Office of Cybersecurity and Communications or Office of Cyber and Infrastructure Analysis, which have already performed work in regard to EMP threats?

Answer. Response was not received at the time of publication.

Question 2. Is DHS reviewing those EMP Commission recommendations that have not been addressed? If so, what is being done to address them?

Answer. Response was not received at the time of publication.

Question 3. GAO recommended that DHS increase its collection and analysis of threat, vulnerability, and consequence information related to electromagnetic risks. GAO also provided a variety of methods through which this can be accomplished, including closer collaboration with DOD and leveraging existing assessment tools, such as the Infrastructure Survey Tool. What has DHS done to increase its collection and analysis of electromagnetic threat information?

Answer. Response was not received at the time of publication.

QUESTION FROM CHAIRMAN SCOTT PERRY FOR JOSEPH MCCLELLAND

Question. Has FERC assessed the potential costs of mitigating critical electric assets to withstand a GMD or EMP? If so, what are they and are there funding streams that could be shifted for some of these costs?

Answer. FERC has not itself assessed the potential costs of mitigating critical electric assets to withstand a GMD or EMP event. A study conducted by the Oak Ridge National Laboratory in 2010, sponsored by FERC and other Federal agencies and to which I referred in my prepared testimony, includes some estimates of such costs.