AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

S. HRG. 114–506

THE DEPARTMENT OF ENERGY'S FUNCTIONS AND CAPABILITIES TO RESPOND TO ENERGY-RELATED EMERGENCIES, INCLUDING IMPACTS TO CRITICAL ENERGY INFRASTRUCTURE

FIELD HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED FOURTEENTH CONGRESS

SECOND SESSION

AUGUST 15, 2016



Printed for the use of the
Committee on Energy and Natural Resources

Available via the World Wide Web: http://www.govinfo.gov

U.S. GOVERNMENT PUBLISHING OFFICE

21–997 WASHINGTON : 2018

For sale by the Superintendent of Documents, U.S. Government Publishing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

COMMITTEE ON ENERGY AND NATURAL RESOURCES

LISA MURKOWSKI, Alaska, *Chairman*

JOHN BARRASSO, Wyoming
JAMES E. RISCH, Idaho
MIKE LEE, Utah
JEFF FLAKE, Arizona
STEVE DAINES, Montana
BILL CASSIDY, Louisiana
CORY GARDNER, Colorado
ROB PORTMAN, Ohio
JOHN HOEVEN, North Dakota
LAMAR ALEXANDER, Tennessee
SHELLEY MOORE CAPITO, West Virginia

MARIA CANTWELL, Washington
RON WYDEN, Oregon
BERNARD SANDERS, Vermont
DEBBIE STABENOW, Michigan
AL FRANKEN, Minnesota
JOE MANCHIN III, West Virginia
MARTIN HEINRICH, New Mexico
MAZIE K. HIRONO, Hawaii
ANGUS S. KING, JR., Maine
ELIZABETH WARREN, Massachusetts

COLIN HAYES, *Staff Director*
PATRICK J. MCCORMICK III, *Chief Counsel*
TRISTAN ABBEY, *Senior Professional Staff Member*
Brianne Miller, *Professional Staff Member*
ANGELA BECKER-DIPPMAN, *Democratic Staff Director*
SAM E. FOWLER, *Democratic Chief Counsel*
RICH GLICK, *Democratic General Counsel*
BRIE VAN CLEVE, *Democratic Science & Technology Fellow*

CONTENTS

OPENING STATEMENTS

	Page
Cantwell, Hon. Maria, Ranking Member and a U.S. Senator from Washington	1

WITNESSES

Moniz, Hon. Ernest, Secretary, U.S. Department of Energy	5
Ezelle, Robert, Director, Washington State Emergency Management Division	51
Bowman, Stephanie, Commissioner, Port of Seattle (Washington)	58
Hairston, John, Chief Administrative Officer, Bonneville Power Administration, U.S. Department of Energy	63
Rogers, Scot, Executive Vice President & General Counsel, F5 Networks, Inc.	73
Imhoff, Carl, Manager, Grid Research Program, Pacific Northwest National Laboratory, U.S. Department of Energy	78
Best, Dr. Lynn, Chief Environmental Officer, Seattle City Light	87

ALPHABETICAL LISTING AND APPENDIX MATERIAL SUBMITTED

Best, Dr. Lynn:	
Opening Statement	87
Written Testimony	90
BNSF Railway:	
Statement for the Record	110
Bowman, Stephanie:	
Opening Statement	58
Written Testimony	60
Cantwell, Hon. Maria:	
Opening Statement	1
Chart entitled “Oil trains moving through Washington”	47
Ezelle, Robert:	
Opening Statement	51
Written Testimony	54
Hairston, John:	
Opening Statement	63
Written Testimony	65
Imhoff, Carl:	
Opening Statement	78
Written Testimony	82
Moniz, Hon. Ernest:	
Opening Statement	5
Clear Path IV: Energy-Focused Disaster Response Exercise Summary Report, April 19–20, 2016	9
Written Testimony	24
Rogers, Scot:	
Opening Statement	73
Written Testimony	76

THE DEPARTMENT OF ENERGY'S FUNCTIONS AND CAPABILITIES TO RESPOND TO ENERGY-RELATED EMERGENCIES, INCLUDING IMPACTS TO CRITICAL ENERGY INFRASTRUCTURE

MONDAY, AUGUST 15, 2016

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Seattle, Washington.

The Committee met, pursuant to notice, at 11:30 a.m. PDT at the Campion Ballroom at Seattle University, Seattle, Washington, Hon. Maria Cantwell, presiding.

OPENING STATEMENT OF HON. MARIA CANTWELL, U.S. SENATOR FROM WASHINGTON

Senator CANTWELL [presiding]: Today's meeting will come to order. I want to thank everyone for being here today. I especially want to thank Secretary Moniz for traveling to the Pacific Northwest to be part of this historic field hearing.

I want to thank Seattle University and Father Sundborg, who I know is not here today, for hosting us again. We were here last year to discuss issues with Senator Barrasso related to the fire season and some great work came out of that hearing, so I expect the same out of this morning's discussion.

First we are going to hear from Secretary Moniz and have a chance to discuss with him, for the official record, a variety of issues, mostly related to the Quadrennial Energy Review and updating our energy infrastructure.

We will then hear from a group of Northwest experts on the second panel: Dr. Lynn Best, who is with Seattle City Light; Stephanie Bowman, from the Port of Seattle; Robert Ezelle, with the Washington Department Emergency Management; John Hairston, with the Bonneville Power Administration; Carl Imhoff, from Pacific Northwest National Lab; and Scot Rogers, with F5 Networks. I look forward to hearing everyone's comments and to the discussion we are going to have today.

I want to welcome the Secretary to the Pacific Northwest and thank him for coming to visit us. We are very proud of our history of innovation in the Northwest and the energy mix of our electricity grid.

We have already had a busy morning. Secretary Moniz and I just recently visited the Bullet Foundation and discussed some of the smart building and zero energy building developments happening

in the Northwest. Later, we will go over to the University of Washington to see more great innovation and then to the Tri-Cities tomorrow to look at the Hanford site and Hanford issues.

It is not every day that an Energy Secretary makes two days available for a particular region of the country, but I think our region deserves to have that much attention because of the challenges and the level of innovation that is happening here.

Mr. Secretary, before I begin my formal remarks, I want to thank you again for making so much time for us and for your great service to our country.

Secretary MONIZ. Thank you for hosting me.

Senator CANTWELL. With that, we will start the hearing which, as I said, is really a hearing to talk about updating and securing our critical infrastructure and energy resources.

The United States is experiencing a very dramatic transformation in how we produce and transport energy. Many of these changes are positive. A more modern grid enables greater quantities of clean sources of energy. Consumers are able to more efficiently use energy and choose low cost alternatives to meet their needs.

We also know that these changes can produce greater stress on our energy transportation infrastructure. For example, crude by rail or pipeline challenges.

The energy industry and federal and state and local governments must work more closely together on these to update our energy infrastructure to satisfy demands for reliable, safe and affordable energy.

As I mentioned, many of these issues are discussed in the Secretary of Energy's Quadrennial Energy Review, issued last year to communicate the many, many energy-related challenges we face. Today we are going to talk about three of those specific challenges, those that really concern us here in the Northwest.

First, we are going to discuss the pressure that increased domestic production of oil has been placing on our rail system, everything from pushing commodities off the rails to issues of public security. The energy transformation the nation is experiencing is impacting the transportation infrastructure, and we, in the Northwest, know how much it is impacting us.

Last year the Quadrennial Energy Review concluded that increased domestic oil production had altered transportation of liquid fuels and for us, in fact, from 2010 to 2015, rail shipments to the West have increased by 10,000 percent. That is almost a mind boggling statistic.

We went from having almost no prior train oil traffic to having almost 20 trains a week going through every major population center in our state. Cities like Vancouver, Spokane and Seattle are very concerned about the safety of these oil trains and the high profile of incidents that have occurred across the nation including a recent derailment that happened in Mosier, Oregon. Twenty-six cities in our state have already passed resolutions expressing concern or just outright opposition to oil trains. This is something even the President, when he was here recently, heard about.

The second issue we want to focus on, as it relates to our infrastructure, again called out in the Quadrennial Energy Review, is

the need to enhance and prevent cyberattacks. A successful attack on our grid, as we know in the Northwest, could have catastrophic outcomes. According to the University of California, Berkeley, power disruptions already cost our U.S. economy $96 billion annually.

Today's economy depends upon a well-functioning and robust electricity grid. As we continue to grow more reliant on the Internet to manage the grid and energy-consuming products, cybersecurity will become even more important.

The Quadrennial Energy Review noted that in 2013, 151 different cyber incidents involving the energy sector were reported to the Department of Homeland Security. I know there is an ongoing effort by the Secretary, working with our national labs and Homeland Security and various industry, to work on preventing cyberattacks in the future.

But I think we are here today to discuss the ideas that we should be pursuing as our information age architecture continues to grow, that our investment in cybersecurity should continue to grow. Today almost everything and everyone relies on a well-functioning electricity grid. Our hospitals, our first responders, our water treatment facilities, fueling stations, transportation communications, everything will be impacted by a prolonged blackout.

As we will hear from F5 this morning, most of our investment to date has been focused on protecting the security of our networks. Much more needs to be done to invest in the security of our software systems. Software attacks are growing. State agents, acting on behalf of foreign governments or terrorist organizations, have attempted almost on a daily basis to hack into our electricity grid.

We have heard stories that maybe the Russians are behind the attacks on computers at the Democratic National Committee and that the North Koreans were involved or perhaps involved in the Sony system hack two years ago. We need to redouble our efforts to thwart not only cyber but physical attacks against the grid as well and to make sure we are continuing to make investments to upgrade our infrastructure.

I think the Secretary may also have some announcements about that today as it relates to Northwest companies and continuing to make that investment. But we do have many, many Northwest companies that, from big data to Smart Grid, are trying to help build out the infrastructure that will keep us ahead of some of these attacks.

Finally, as the climate continues to change, more attention needs to be paid to the impacts of that and natural disasters, severe weather, all of these things, also impact our energy infrastructure. We know in the Pacific Northwest what a one-degree change in temperature means for snow melt and what a big impact it has on our hydro system.

Government has an obligation to coordinate with the private sector to reduce the impacts of natural disasters on our energy infrastructure. This is especially important for us in the Northwest where we are susceptible to earthquakes, fires, droughts, floods and landslides and getting the energy system up and operating again is critical.

Secretary Moniz is going to, I believe, release a report today about the Department of Energy's (DOE) recent Clear Path IV exercise. This exercise examined how well the Pacific Northwest energy sector might respond to a massive earthquake associated with a tsunami. The findings suggest that we have more to do to enhance our energy security but clearly the Federal Government needs to play a role in helping us get that plan into action.

We are sitting in the middle of the Cascadia subduction zone which can produce very strong earthquakes and corresponding tsunamis, and an event of this magnitude could wipe out the infrastructure that brings electricity and fuel for a very long time. The Department of Energy's findings from its Clear Path IV exercise are particularly illuminating.

First, we need to help the energy sector assess the damage from natural disasters more quickly and more accurately to facilitate the restoration of service. The Pacific Northwest National Lab is developing technology on this that will help expedite those assessments.

Second, the Federal Government needs to use its resources to enhance the effect of the state and local industry efforts to restore the energy infrastructure. We all know what happens when we have a storm and the amount of time we have tried to cut down on getting electricity grids back up and operational by coordinating with utilities all throughout the region. Imagine this on a much grander scale.

Third, the Department of Defense and other agencies can provide aviation and maritime resources to transport and replace equipment such as electric transformers and hard hit areas not able to be reached by road. Federal agencies can also help make sure that we have enhanced infrastructure and coordination for the restoration of those energy sector areas.

I look forward to hearing more about this report from the Secretary.

We are already working on some of these ideas in Congress. We just recently passed out of the Senate a comprehensive energy bill, the first one in nine years, and this bill is now in conference. It includes important provisions for doubling our efforts on research for the grid and specifically targeting cyberattacks. It would fund modernization to make the grid more flexible in the cases of emergency. It also puts the Energy Secretary in charge of developing and implementing a response for energy emergencies. So I am so pleased that he is here today to discuss that. We also, in the bill, make sure that we continue to focus on upgrading our energy infrastructure as it relates to the grid and a workforce that it will take to accomplish that.

Again, we want to welcome the Energy Secretary here today, and thank him for coming to the Northwest and looking at all the innovation that the Northwest has to offer. For example, we just toured a smart building. The Energy bill would upgrade our Smart building efforts through the Department of Energy's help and hopefully reduce the amount of energy used. About 40 percent of all energy is consumed now in buildings.

Mr. Secretary, again, thank you for being in the Pacific Northwest. Our hearing process is usually five minutes for opening state-

ments, even for a Secretary, but today we are waving that rule. We are in the Northwest, and we are going to make our own rule.

Please use whatever time you would like this morning to present your testimony and discuss any issues you think are relevant to today's subjects.

STATEMENT OF HON. ERNEST MONIZ, SECRETARY, U.S. DEPARTMENT OF ENERGY

Secretary MONIZ. Great.

Well thank you, Senator Cantwell. I really appreciate the opportunity to address the Department of Energy's responsibilities for helping the energy sector prepare and respond to a wide range of threats and hazards at a time, as you said, of rapidly changing energy systems, dramatically increased oil and gas production, driving exports, engaging new geographies requiring infrastructure development. Market structures are shifting. Natural gas displacing coal. Dramatic renewables growth. Efficiency, challenging business models. It's really one of the most dynamic times, I think, we've ever seen in the energy system. And as you have said, that spills over into infrastructure challenges that we will discuss today.

But I do want to take the opportunity, given the lack of a 5-minute clock, to also thank you for collaboration and for your leadership in this and in other issues and particularly single out your commitment to innovation. I think we are very well aligned on that. And also your leadership in emphasizing the regional nature of innovation and our opportunities to improve regional ecosystems here in the Northwest, but also across the country. We're going to need that to succeed in our energy and climate goals. So again, thank you for all of that, not to mention a great time here in Seattle.

So, as President Obama has pointed out, our energy and communication systems enable all other infrastructures to function. And of course, communications in turn, depend upon electricity. So, if we don't protect the energy sector, we're putting, essentially, every other sector in the economy in peril.

When the DOE was established in 1977, the nation's energy vulnerability was perceived mainly to be the threat of physical disruption of oil supplies. Though DOE did inherit emergency authorities from precursor agencies, and I'll come back to those, the only reference to emergency response in the DOE Organization Act was direction for DOE to develop "an effective strategy for distributing and allocating fuels in periods of short supply." So very, very narrow reference to the issues of those days.

Now fast forward to this century, and we face a very different set of threats to our energy systems. In response there are now laws, actions and Presidential directives that are focused on threats such as severe weather, natural disasters, EMP, aging infrastructure, cyber and physical threats. So it's a considerably broadened threat spectrum that we need to consider.

We need to make energy infrastructure investments commensurate to the critical role of that infrastructure and to today's threat environment. In particular, the reliance of all of our critical energy infrastructures on electricity places a very high premium on reli-

able, modern and hardened electric grid resistant to the continually evolving cyber threats.

And, I'll come back to this later, that is why in the second installment of the Quadrennial Energy Review, that you referred to earlier, we are focusing on the electricity system, end-to-end, including the entire threat surface. So that is something that, I think, we get, we share an appreciation of that priority.

Now DOE does have some long standing emergency authorities. During emergencies the Department has independent authority to order temporary electricity connections, to make exchanges of crude oil or petroleum products from our reserves, to assist entities in procuring necessary energy materials to maintain supply during an emergency and to control nuclear materials.

We also have authorities that require a Presidential finding including orders to protect or restore the reliability of critical infrastructure, sales from the petroleum reserve, allocation of energy materials in the civilian market and allocation of natural gas and fuel switching in power plants. So those can all follow a Presidential determination.

Finally, DOE has a consultative role for Jones Act waivers and a concurrence role for fuel waivers during emergencies. Now these authorities have been used many times. The Department has used its independent authority to connect temporary electricity lines, for example, to restore power after hurricanes like Ike, Katrina and Rita. After Super Storm Sandy, the Department loaned 120,000 barrels from the Northwest Home Heating Oil Reserve, NHHOR, to the Department of Defense for use in emergency responder vehicles, essentially low sulfur diesel fuel.

DOE also has had legislation and directives related to new emergency response authorities. The California electricity crisis of 2000–2001 actually led to the use of multiple authorities deriving from the Federal Power Act, the Defense Production Act and the Natural Gas Policy Act.

Now with regard to new authorities and responsibilities, the FAST Act that you referred to, the Transportation bill, provides DOE with a new authority to protect critical infrastructure against cyber, EMP, geomagnetic disturbance and physical attack threats. These authorities do not apply, however, to natural disasters other than geomagnetic storms. So while these authorities are welcome, they do create an asymmetric situation for authorities for natural disasters and malevolent attacks even though the outcomes could be similar.

The 2015 Balanced Budget Act directs DOE to establish a strategic petroleum reserve modernization program to protect the U.S. economy from the impacts of emergency products supply disruptions, and I will return to this later.

Finally, in terms of new responsibilities and authorities, President Obama has addressed these issues through Presidential Policy Directive 21 which identifies DOE as the sector-specific agency for energy infrastructure, making it the federal lead for the prioritization and coordination of activities to strengthen the security and resilience of critical energy infrastructure.

The DOE also serves within the Administration as the lead agency for Emergency Support Function 12 which facilitates recovery

from disruptions to energy infrastructure. During a response operation the Department works with industry and federal, state and local partners to assess disaster impacts on energy infrastructure, coordinate response to expedite restoration and to monitor and provide situational awareness of impacts to key decision-makers. The Department deploys responders who work directly with affected utilities and local officials on the ground during a disaster. Our response force is entirely voluntary and we are training right now nearly 100 members of our staff to be prepared to deploy for all hazard contingencies.

Over the past two years our Deputy Secretary and I have led a deliberate effort to strengthen our emergency response capabilities and our critical partnerships with the energy sector. With 90 percent of the nation's power infrastructure privately owned and operated, coordinating and aligning efforts between the government and the private sector is necessary to be effective in emergency response.

Our challenge here is speed. If we have a government process that takes too long to share information about dynamic threats, then we're going to fail to protect our infrastructure. Our solution is to provide tools, information and practice so that companies are aware of risks as soon as they're identified. We can bring together information across the Department and across the government and then take action together. We also partnered with state, local and tribal governments with an updated Energy Emergency Assurance Coordinators MOU that I signed early this year. DOE will enhance robust training and exercising, bringing stakeholders together to plan for shared regional hazards, and I will come back to an example of that.

One of DOE's core missions, and you've said it already several times which I appreciate, is to support innovation and that includes innovation to help our nation's energy security. So we are growing our partnerships with academia and the private sector and, of course, leveraging our 17 national laboratories in order to make our infrastructure more secure and resilient.

At this time I will say that in this state we have one of our premier national laboratories, specific Northwest, East of the Cascades. You all should take a trip over the mountains and we will tomorrow, in fact, do that to visit that laboratory. Of course, it will require substantial additional investment over many years to expand transformational innovation that can outpace the dynamic threats that we face. And here I will say that across the board the President's Fiscal Year 2017 budget proposes the first increment of energy R and D funding to meet Mission Innovation goals, specifically a doubling of our energy related R and D over a five-year period. It also proposes regional innovation partnerships and again, Senator Cantwell has been a leader in advocating for this approach, no doubt helped by the fact that she anticipates this area would have a very robust regional response given all of the intellectual and other assets in this part of the country.

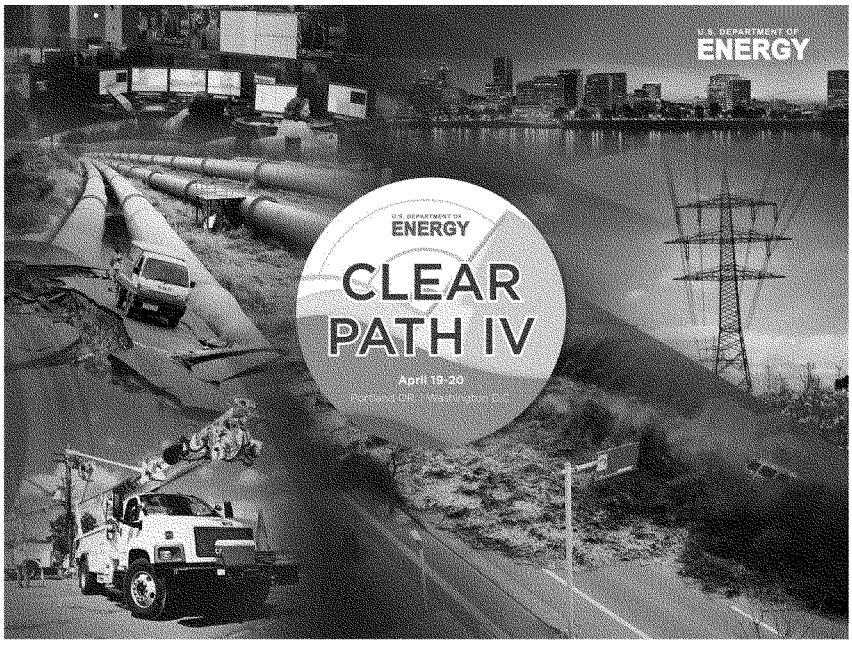
This budget will provide a very strong foundation for addressing the infrastructure needs discussed here as well, again, as the broader clean energy investments needed for our economic, environmental and security goals.

Today we are announcing $30 million of funding. That may actually have some additional funding added to it next year, but for today $30 million of funding for cybersecurity, including research and development and programs to develop energy professional education in cybersecurity. Two of the awards are in Washington State. They are the Schweitzer Engineering company in Pullman, Washington with a total of about $7.5 million for the company in developing its cybersecurity software products. That's a terrific development across the board but certainly as well here in Washington State.

Now, robust exercises are also crucial to ensure industry and government are better prepared to work as a team during real world emergencies.

In April 2016 DOE led Clear Path IV, an interagency exercise focused on testing and evaluating energy sector response plans in a scenario depicting a Cascadia Subduction Zone 9.0 earthquake and tsunami, the so-called really big one, made famous in the New Yorker article.

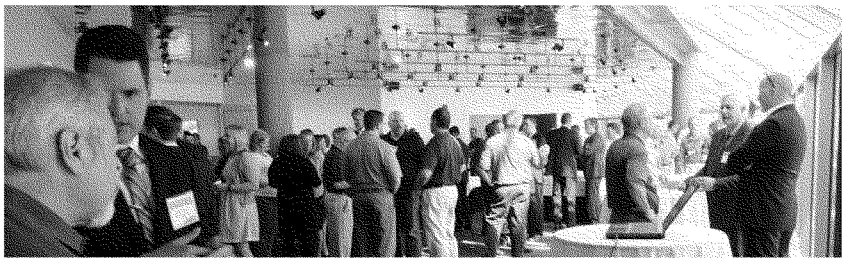
[The information referred to follows:]



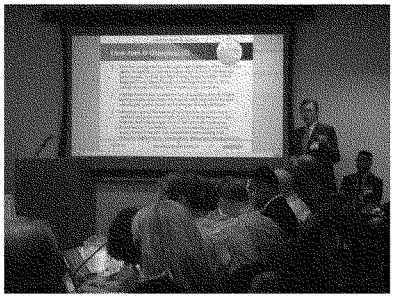
U.S Department of Energy *Clear Path IV* Energy-Focused Disaster Response Exercise

April 19-20, 2016

Exercise Summary Report

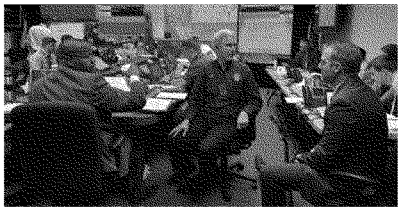












HANDLING INSTRUCTIONS

1. The title of this document is *Clear Path IV* Energy-Focused Disaster Response Functional Exercise (*Clear Path IV*) Summary Report. The exercise overview, goals, and objectives in this manual reflect the information that was distributed to participants at *Clear Path IV*.
2. This document is approved for public release.
3. For more information on this exercise, please consult the following point of contact:

Puesh Kumar
Director, Infrastructure Security and Energy Restoration
Office of Electricity Delivery and Energy Reliability
United States Department of Energy
Phone: (202) 586-9600
Email: Puesh.Kumar@hq.doe.gov

Evan Musolino
Z, Inc. Contract Support to
Infrastructure Security and Energy Restoration
Office of Electricity Delivery and Energy Reliability
United States Department of Energy
Phone: (202) 586-5082
Email: Evan.Musolino@hq.doe.gov

TABLE OF CONTENTS

Handling Instructions ..... **iii**
Table of Contents ..... **iv**
Exercise Overview **1**
General Information **3**
Introduction 3
Exercise Overview 3
Participation 5
Conclusion and Recommendations **7**

EXERCISE OVERVIEW

Exercise Name	*Clear Path IV* Energy-Focused Disaster Response Exercise (*Clear Path IV*)
Exercise Date	April 19-20, 2016
Exercise Location	World Trade Center (Portland, OR) (Day 1 and 2) Department of Energy Headquarters (Washington, DC) (Day 2)
Purpose	*Clear Path IV* addressed the challenges the energy sector may face during a catastrophic Cascadia Subduction Zone (CSZ) earthquake and tsunami, focusing on the collaboration between government and industry during efforts to organize response, assess impacts to energy systems, communicate information to develop situational awareness and a common operating picture, and facilitate the delivery of capabilities across internal and mutual assistance networks.
Scope	This exercise was divided across two days of play. Day 1 was a discussion-based rehearsal-of-concept tabletop exercise (TTX), which focused on strategic-level response operations and the coordination between government and industry. Day 1 explored specific components of the energy sector's incident response, to include joint operations, fuel system management, power restoration, and state coordination. Day 2 was an operational- and tactical-level functional exercise played from the DOE Emergency Operations Center (EOC) in Washington, DC, coordinated with simulated field operations in the Pacific Northwest, by the DOE headquarters' Unified Command Structure (UCS).
Classification	UNCLASSIFIED
Core Capabilities	• Community Resilience • Critical Transportation • Infrastructure Systems • Logistics and Supply Chain Management • Long-Term Vulnerability Reduction • Planning • Public Information and Warning • Operational Coordination • Risk and Disaster Resilience Assessment • Situational Assessment

Objectives	• Examine energy sector roles and responsibilities within response plans utilized for a Cascadia Subduction Zone 9.0 earthquake and tsunami, such as the DOE Energy Response Plan, FEMA Regional Plans, State Emergency Management Plans, State Energy Assurance Plans, and industry response plans. • Highlight strategies to address fuel disruptions and shortages during a multi-state regional disaster with impacts to oil and natural gas supply chains and methods of transportation. • Identify essential elements of information and determine methods and processes of information sharing between state, federal, and industry partners to best provide situational awareness and to develop a common operating picture to support executive and operational decision making and resource requirements, adjudication, allocation, and disposition. • Determine effective identification of critical resources and capabilities, eliminate duplication of requests or delivery, and determine logistical requirements with commercial and governmental methods within multiple mutual assistance networks and systems. • Prioritize the restoration of energy systems with state, federal, and industry partners with consideration to cascading impacts to interdependent sectors. • Evaluate the DOE Unified Command Structure Concept of Operations with federal, state, and industry partners in responding to the CSZ disaster.
Scenario	A magnitude 9.0 earthquake and subsequent tsunami occurs along the 700-mile-long CSZ, causing considerable damage to Washington, Oregon, and parts of northern California. Effects are felt many miles inland, and impacts include landslides, liquefaction, and damage to critical infrastructure, buildings, and structures. Collateral damage results from fire, release of hazardous materials, failure of essential operating systems, and disrupted lifeline services.
Participating Organizations	Stakeholders from federal, state, and local governments; electricity industry; oil and natural gas industry and key domestic and international partners participated in *Clear Path IV*. Please see **Figure 3** for a complete list of exercise participants.

GENERAL INFORMATION

Introduction

This *Clear Path IV* Summary Report provides observations of exercise conduct and recommendations for the energy sector, both government and industry, to improve policies, plans, and procedures for energy emergencies.

Exercise Overview

The U.S. Department of Energy (DOE) Office of Electricity Delivery and Energy Reliability's (OE) Infrastructure Security and Energy Restoration (ISER) division hosted the *Clear Path IV* Energy-Focused Disaster Response Exercise (*Clear Path IV*) on April 19 and 20, 2016, in Portland, Oregon and Washington, DC. The *Clear Path* series is a critical component of DOE's efforts to strengthen cooperation between government and industry on emergency response in order to better facilitate the restoration of energy services the aftermath of catastrophic incidents. *Clear Path IV* was designed to elicit outcomes aimed at helping inform government and industry response plans as well as shape energy sector participation in the Cascadia Rising 2016 exercise sponsored by the Federal Emergency Management Agency (FEMA), Department of Defense (DOD), and the States of Washington, Oregon, and Idaho. Additionally, in the coming months, stakeholders in the Pacific Northwest will leverage *Clear Path IV* outcomes to shape the development of a FEMA Region X Power Outage Incident Annex, which is a regional plan for government and industry representatives on responding to long duration power outages.

The exercise scenario consisted of a magnitude 9.0 earthquake and subsequent tsunami occurring along the 700-mile long Cascadia Subduction Zone (CSZ), causing catastrophic damage to Washington, Oregon, and northern California. Simulated earthquake and tsunami effects were felt many miles inland, with landslides and liquefaction causing significant damage to critical infrastructure and buildings. Cascading impacts caused by collateral damage from fire, hazardous materials, failure of essential operating systems, and disrupted lifeline services threatened the communities of the Pacific Northwest.

Figure 1 identifies the following National Preparedness Goal Core Capabilities examined in *Clear Path IV*.

Figure 1: *Clear Path IV* Core Capabilities

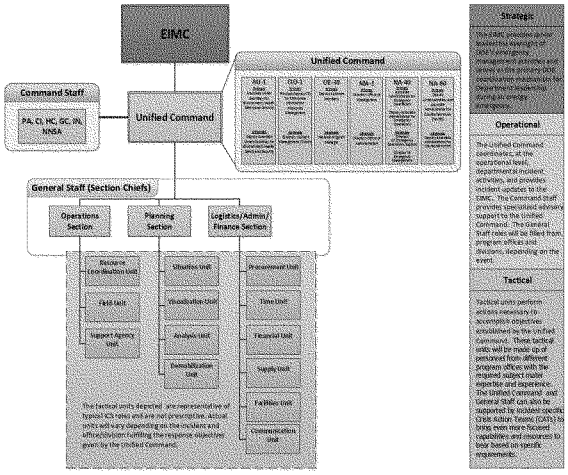
Community Resilience	Planning
Critical Transportation	Public Information and Warning
Infrastructure Systems	Operational Coordination
Logistics and Supply Chain Management	Risk and Disaster Resilience Assessment
Operational Communication	Situational Assessment

Clear Path IV was designed to serve as an important milestone in DOE's process to reorganize its emergency response enterprise to align with National Incident Management System (NIMS) guidelines and better leverage the tremendous expertise found throughout the Department during incident response operations. A Unified

Command Structure (UCS)[1] was activated such that individuals from the OE, the U.S. Energy Information Administration (EIA), and the National Nuclear Security Administration's (NNSA) were co-located in the NNSA's Emergency Operations Center (EOC) to jointly coordinate response efforts. Also, *Clear Path IV* was designed to prompt DOE leadership organized under the Emergency & Incident Management Council (EIMC) to provide strategic direction and facilitate DOE resources for response efforts. Due to the nature of the incident, operations in the EOC were led by OE/ISER with ISER staff taking leadership roles in the Unified Command Group, the General Staff (Section Chiefs) and Command Staff levels, augmented with support from NNSA and other members of the UCS.

Figure 2 depicts DOE's UCS as it was staffed and its operations evaluated during the functional component of *Clear Path IV* on April 20th. See footnote 2 for description of DOE offices abbreviated below.[2]

Figure 2: DOE Unified Command Structure



[1] The DOE Unified Command Structure (UCS) is designed to increase cooperation and coordination across the DOE Emergency Management Enterprise, encapsulating functions from OE's Energy Response Organization, the NNSA's Emergency Management Teams and Programs, AU's Physical Security Operations, the OCIO's Cyber Security and Response Function, IN's intelligence support Activities, and MA's Occupant Emergency Programs. DOE's proposed UCS was used for this exercise. The Department plans for UCS Initial Operating Capability by December 2016.

[2] *EIMC*: Emergency & Incident Management Council (EIMC)
Command Staff: Public Affairs (PA), Congressional and Intergovernmental Affairs (CI), Chief Human Capital Officer (HC), General Counsel (GC), Intelligence and Counterintelligence (IN), National Nuclear Security Administration (NNSA)
Unified Command: Associate Under Secretary for the Office of Environment, Health, Safety and Security (AU-1), Office of the Chief Information Security Officer (CIO-1) Office of Electricity Delivery and Energy Reliability Infrastructure Security and Energy Restoration division (OE-30), Office of Management (MA-1), NNSA Associate Administrator for Emergency Operations (NA-40), NNSA Associate Administrator for Counterterrorism and Counterproliferation (NA-80)

Participation

Approximately 200 participants from Federal, state, and local government as well as the electric sector and oil and natural gas industries participated in Clear Path IV over the 2-day event from Portland, OR and Washington, DC.

Figure 3. Exercise Participants

Federal Government		
Bonneville Power Administration	Department of Homeland Security	United States Army Corps of Engineers
Department of Commerce	Environmental Protection Agency	United States Bureau of Reclamation
Department of Defense	Federal Emergency Management Agency	United States Coast Guard
Department of Energy		Western Area Power Administration
State Government		
State of Arizona	State of Montana	State of Utah
State of California	State of Oregon	State of Washington
State of Idaho	Oregon Army National Guard	Washington Army National Guard
Local Government		
Clackamas County (OR)	Multnomah County (OR)	City of Portland (OR)
Marion County (OR)	Washington County (OR)	City of Salem (OR)
Oil and Natural Gas Industry		
BP	Kinder Morgan	Shell
Chevron	Marathon Petroleum	Tesoro
Devon Energy	NW Natural	TransCanada
ExxonMobil	Phillips 66	U.S. Oil and Refining Co.
		Williams
Electric Industry		
APR Energy	Exelon Corporation	Seattle City Light
Clark Public Utilities	NV Energy	Snohomish County Public Utility
Consolidated Edison	PacifiCorp/Pacific Power	Southern California Edison
Coos-Curry Electric Cooperative	Pacific Gas and Electric	Springfield Utility Board
Eugene Water and Electric Board	Portland General Electric	Tacoma Public Utilities
	Puget Sound Energy	
Key Partners		
American Fuel and Petrochemical Manufacturers	HAMMER Federal Training Center	NJ Resources
American Petroleum Institute	National Association of Regulatory Utility Commissioners	Oregon Municipal Electric Utilities Association
American Public Power Association	National Association of State Energy Officials	Oregon Rural Electric Cooperative Association
ARCOS	National Energy Technology Laboratory	Pacific Northwest National Laboratory
Civil Air Patrol	National Governors Association	Peak Reliability
Edison Electric Institute	National Petroleum Council	Western Electricity Coordinating Council
Electric Infrastructure Security Council	National Rural Electric Cooperative	
Electricity Sector Information		

Sharing & Analysis Center Electricity Subsector Coordinating Council	Association	
International Partners		
Israel National Emergency Management Authority	Natural Resources Canada	Pontificia Universidad Católica de Chile

CONCLUSION AND RECOMMENDATIONS

As the first functional test of DOE's unified response concept, *Clear Path IV* was a major step forward in the development of an enterprise-wide emergency response concept of operations capability in DOE and across the energy sector. DOE validated the concept of operations governing its emergency management operations as DOE personnel successfully demonstrated the capacity to manage a complex natural hazard incident while simultaneously managing a nuclear weapon accident/incident exercise. At the same time, DOE personnel were able to identify important lessons to improve implementation of that concept.

Perhaps equally important, *Clear Path IV,* in its design and conduct, represented a qualitative and quantitative improvement over previous editions of the *Clear Path* series. Prior to this most recent iteration of the *Clear Path* series, the annual DOE event was a Washington, D.C.-based hurricane response tabletop exercise. Moving to a functional exercise with response elements located both in the field (in Washington and Oregon) and DOE headquarters, *Clear Path IV* provided a number of opportunities to enhance mutual learning within the energy sector. The increased complexity of this exercise presented participants with a more demanding environment, driven by the catastrophic conditions of the earthquake scenario.

Clear Path IV also succeeded in involving different participants than had been seen at previous *Clear Path* exercises. In prior *Clear Paths*, participants were primarily D.C.-based representatives from industry, state government trade associations, and federal government agencies. By hosting *Clear Path IV* on the west coast, DOE was able to involve individuals at the regional, state and local levels in addition to the aforementioned representatives from previous exercises. DOE also expanded its outreach to industry for *Clear Path IV,* incorporating both electricity and oil and natural gas sector representatives in the planning and design of the exercise from the outset, to the great benefit of the exercise.

The exercise provided a comprehensive test of the ability of energy sector representatives from both government and industry to respond to a catastrophic incident. DOE is continuing to work in collaboration with government and industry partners to ensure the lessons learned in *Clear Path IV* are considered or implemented. DOE will conduct a series of follow-on meetings with federal interagency partners, states, electric sub-sector, and the oil and natural gas sub-sector to develop roadmaps for implementation to create positive change within the energy sector response community. The benefit of continuous engagement is to foster and enhance critical partnerships across the emergency management enterprise, both government and industry, while improving collaborative planning efforts. Continued efforts of both government and industry officials to improve the ability of the energy sector to prepare for, respond to, and recover from catastrophic incidents should be guided by the following Recommendations:

1. The whole community – to include the U.S. Department of Energy (DOE) and other federal agencies, state, local, and tribal governments, and industry partners - should build on the successful collaboration witnessed at Clear Path IV by establishing and communicating consistent incident coordination mechanisms, protocols, and procedures to facilitate energy restoration.

2. DOE should enhance its ability to advocate with other federal agencies on behalf of the energy industry for federal assistance to facilitate information gathering and energy restoration in the aftermath of an event. The Department should also work in partnership with industry to inform response partners and the general public of the status of energy restoration to set realistic expectations.

3. The energy sector should work with the response community to clearly articulate the physical and operational constraints faced by the electricity and oil and natural gas industries (e.g., predetermined

restoration pathways or antitrust concerns) which will impact energy restoration. The whole community should use this enhanced knowledge to ensure these constraints do not impede the Nation's ability to prepare for, protect against, respond to, recover from, and mitigate all hazards.

4. DOE and the energy industry should improve their coordination by ensuring that agencies and organizations providing critical services in support of energy restoration are better integrated into each other's planning activities and exercise events. This will allow the community to further enhance the cross-sector and multi-jurisdictional collaboration that was demonstrated during Clear Path IV by developing and testing coordinated procedures prior to real world events.

5. DOE should augment the human, physical, and technical resources of its Unified Command Structure and its Emergency Operations Center in order to enhance its effectiveness.

DOE has already begun to take action on the *Clear Path IV* recommendations, enabling the Department to further refine and implement the concept of operations governing its integrated emergency response enterprise. DOE will also continue to take a leading role in engaging with external stakeholders on important initiatives designed to enhance the preparedness and resiliency of the energy sector, such as the FEMA Region X Power Outage Incident Annex. While *Clear Path IV* has been recognized as a success by many within the sector, the real successes from the exercise will result from the implementation of the recommendations captured in this report.

One outcome of that was the importance of accelerating damage assessments immediately. And as you said, PNNL, Pacific Northwest Laboratory, is right now developing imagery tools to do just that, to bring new technology to bear on making fast assessments of damage so that responders can prioritize where they have to go in order to get not only energy up but to provide all the other services to our displaced people.

Clear Path served to elevate energy sector participation in the subsequent Cascadia Rising exercise which was government-wide in June. That really helped the entire Emergency Management Team to identify resource requirements for natural disaster.

Today, as you said, we are announcing this is a summary, the Clear Path After Action report. I want to say that this Clear Path was very important. It was the first use of our, I mentioned earlier the Deputy Secretary and I have been reorganizing some of the response functions, that included putting together a unified command structure for emergency response. This was the first use of that command structure.

To give you an idea of our complexity, it deals with operations, planning and logistics. But with the Office of Electricity, the emergency response activity in the Office of Electricity, our national Nuclear Security Administration, our Associate Under Secretary for Management Performance who deals with physical security, our CIO cyber activity, our intelligence activity and our management and administration activities which includes procurement. All of those offices which are spread out in the Department, have now, we're trying to, we are organizing under this unified command structure that was exercised for the first time in Clear Path IV.

I might add that in addition, of course, to their participation, for the first time in the Clear Path series, we held it out in the field. This was headquartered out of Portland, in Bonneville, in the field but it was regional. And of course, that allowed us, really, to much more effectively bring in state and local responders into our exercise out here in the field. We also had the energy industry the first time, not only electricity, but the oil and gas sector. We had Canada involved and of course, multiple federal agencies.

So this was a what you need to do so that we're not trying to do it for the first time in an emergency, very effective, as I said. It highlighted the importance of immediate assessment. But it also brought to the fore other things, for example, dealing with industry. The need for waivers. There can be anti-trust issues, particularly in the oil and gas sector. We have to be prepared in advance so that we can do those with speed. So that was really very important, and I believe we need to do much more of this in the future.

Now I'll add that unique to DOE we actually own critical assets in the sector that we are supporting and particularly relevant in, again, this part of the country our preparedness and response activities for our power market administrations like Bonneville directly overlap with what we are trying to do, of course, with the broader energy sector.

So, another important direction, we believe, that we are emphasizing over the last couple of years is to develop what we call enterprise-wide approaches. That unified command structure is an example of an enterprise-wide approach but the idea here, in general,

is to bring all of our resources into play, including those at our national laboratories.

Two examples, two additional examples, of that is we have formed an integrated Joint Cyber Coordination Center. It's a collaborative, intelligence-driven approach to cybersecurity to protect the entirety of the DOE attack surface including DMAs and we are working toward a consolidated emergency operations center to allow our unified command structure to operate out of a single facility.

Finally, let me turn to the issue of managing our strategic energy resources, reserves. We already mentioned that the 2015 Balanced Budget Act, drawing upon a recommendation of the Quadrennial Energy Review (QER), supports modernizing the petroleum reserve. The petroleum reserve physical assets date back many decades, need modernization and frankly, we should also, in my view, revisit some of the operating procedures of the petroleum reserve.

But the Balanced Budget Act, again, following up our QER recommendation, has two phases. Life Extension Phase II will address unanticipated SPR (Strategic Petroleum Reserve) related equipment failures that have been impacting the reserves operational readiness capability. Second, marine terminal distribution capability enhancements will add dedicated marine terminals in each of the SPR's three distribution systems to address the impacts of changes in the U.S. midstream oil movement that have significantly reduced the effective distribution capacity of the SPR in an emergency.

And just last Friday, again, these hearings have a way of focusing the mind. Just last Friday, the Department approved what's called CD–0, the first stage of project management protocols which establishes the mission need for the marine terminal distribution capability. CD–0 was already passed for the modernization, the life extension phase, and we will soon submit a report to Congress on DOE's long term strategic review of the SPR.

So in conclusion, let me say that upon my return to DOE after a 13-year absence, I was struck by the imperatives of a new and complex mission for the Department. Almost nothing that I described in this testimony was present when I left the Department in January 2001. But ensuring resilience, reliability, security and emergency response with significant operational responsibilities is really a new and very important direction for the Department. And again, thank you for your support.

The first installment of the QER, again, addressed these issues of infrastructure, resilience, reliability, safety and asset security. And again, many of those recommendations are in progress. Some of them require new statutory authority. We've received some statutory authority, and these will improve energy infrastructure resilience.

The second installment, as I mentioned, is on the electricity system, end-to-end, and these are all critical for emergency response and for meeting our climate goals. However, the fragmentation of our current emergency responsibilities and assets within the Department, partly reflected in that unified command structure, does present a management challenge. And so, I want to say that we

continue to analyze organizational options in light of these complex, cross-cutting and evolving requirements.

The combination of increasing responsibilities and fragmented management arrangements creates some risk to the Department is not adequately resourced to effectively carry out its responsibilities, and that's an area where we look forward to working with this Committee and with Congress as a whole to provide an appropriately resourced energy emergency response capability as an essential component of a robust energy infrastructure supporting a 21st century economy.

Thank you for your graciousness in affording me the time to provide somewhat longer testimony. But it really is a broad scope of activities, and again, we look forward to solidifying this going forward with your help and the Committee's.

Thank you.

[The prepared statement of Secretary Moniz follows:]

Testimony of Secretary of Energy Ernest Moniz

U.S. Department of Energy

Before the

Committee on Energy & Natural Resources

Subcommittee on Energy

United States Senate Field Hearing

Seattle, Washington

August 15, 2016

Thank you Senator Cantwell and members of the Committee for hosting this Field Hearing in Seattle. I appreciate the opportunity to address the Department of Energy's (DOE) historic, current, and growing responsibilities for helping the energy sector prepare for and respond to a wide range of threats and hazards.

Let me also thank Senator Cantwell, the Committee and the Congress for the recent focus on energy emergency response in both the FAST Act and in the Balanced Budget Act of 2015. These actions underscore the ongoing need to modernize our approaches to, and infrastructure for, responding to energy emergencies in a rapidly changing threat environment and energy space.

Rapidly Changing Energy Systems and Threats

This hearing to examine the current and future Federal role in responding to energy-related emergencies is very timely given that the Nation's energy systems and their vulnerabilities are undergoing significant changes. To appreciate DOE's essential and expanded role in energy emergency response today and in the future, it is important to place this discussion in the context of these remarkable changes and to examine the authorities and resources the Department has to address current and rapidly-evolving threats to these systems. While most of our energy infrastructures are privately owned and operated, energy is foundational to the Nation's economic prosperity and national security. As the President has pointed out, energy and communications systems enable all other infrastructures to function. If we don't protect the energy sector, we're putting every other sector of the economy in peril.

Changed Energy Profile. Let me briefly highlight the dramatically changed energy profile of the United States over the last decade and then discuss the evolving threat environment. The U.S. is now the number one producer of oil and gas in the world and we are producing more oil than we import for the first time in decades. Renewable energy technology deployment is rising and prices are falling. Energy efficiency policies and technologies are contributing to projected slow growth in demand for electricity, and flat or declining demand for oil. Natural gas recently

replaced coal as the largest fuel source for power generation. Importantly, unconventional oil and gas are also being produced in unconventional locations with potential implications for the transportation infrastructure to move these supplies to market, including recent congestion on railroads, inland waterways and ports, which will continue to need to be evaluated. U.S. companies are also exporting oil and natural gas, with security implications for global supply chains.

The April 2015 Quadrennial Energy Review (QER) concluded that in key areas, the country's energy and related infrastructures have not kept pace with changes in the volume and geography of oil and gas production.

Furthermore, integrated North American electricity grids and energy markets have increased the need for joint grid security strategies. The U.S. has new responsibilities for protecting LNG export supply chains. We also remain large net crude oil importers but now are large net oil product exporters as well as exporters of some crude oil; thus, we remain directly tied to world oil markets and global oil price volatility.

Finally, our allies and other key partners have significant energy supply and infrastructure vulnerabilities as was exposed by the 2014 Russian aggression in Ukraine. In response to this aggression, the U.S. and its G-7 partners developed a set of broad and collective energy security principles, two of which are especially important for today's discussion:

- Putting in place emergency response systems, including reserves and fuel substitution for importing countries, in case of major energy disruptions.
- Improving energy systems resilience by promoting infrastructure modernization and supply and demand policies that help withstand systemic shocks.

A discussion of the evolving threat environment should start with the establishment of DOE in 1977 and how its role in emergency response was described in the Department of Energy Organization Act. At that time, the nation's energy vulnerability was perceived to be largely associated with growing oil imports, a global oil cartel, the real threat of physical disruption of oil supplies, and the inadequacy of an effective emergency response mechanism.

The Federal reaction to the Arab oil embargoes, the associated long gasoline lines, and the public's sense of extreme vulnerability led to the establishment of both the Department of Energy and its Strategic Petroleum Reserve (SPR). A reflection of the times, the only reference to emergency response in the DOE Organization Act was fundamentally about gasoline rationing and listed in the purposes of the Department as "[facilitating the] establishment of an effective strategy for distributing and allocating fuels in periods of short supply."

It should be noted that there are other essential emergency authorities, some of which predate the establishment of the Department, that have guided its actions in energy emergencies today and will do so going forward. These will be discussed shortly.

Changing Threat Environment. Fast forward to this century: We face a very different set of threats to our energy systems that guide both the structure and nature of our energy emergency

responses. Energy infrastructure is extending across state and international boundaries. We are also now operating in a post-9/11 threat environment that provides a new context and framework for what we as a Department are responsible for and do in emergency response. We know that adversaries and homegrown actors are interested in the vulnerabilities of our critical infrastructures. In response, there are now a range of laws, actions, and Presidential directives and orders designed to protect our citizens, economy and critical infrastructures from those with malevolent intent. Threats include natural and manmade events such as severe weather, natural disasters, electromagnetic pulses (EMPs), aging infrastructure, cyber threats, and growing infrastructure interdependencies. Some examples are dramatic extreme weather events like Superstorm Sandy, natural disasters like earthquakes and wildfires, and the growing perils of aging infrastructure like at Aliso Canyon, along with lower level but nevertheless troubling occurrences such as a series of as yet unexplained attacks on exposed electricity substations, including the Metcalfe incident in California and the Liberty substation in Arizona. As a result, public consciousness has been raised about the vulnerability of our electric grid and the need for the U.S.to substantially raise its game in addressing those vulnerabilities.

The threat of more devastating malevolent attacks such as EMPs underscores the vulnerabilities associated with the growing reliance of our society on electricity, starting with the "internet of things" where an estimated 50 billion devices or more are connected to an internet that relies on electricity. All of our critical infrastructures – finance, telecommunications, health care, industry, energy, indeed the systems we need to respond to energy emergencies – are connected to and often managed via the internet and they all rely on electricity. This makes our energy systems especially vulnerable to cyber-attacks on the grid and is why the Commander, U.S. Cyber Command and Director, National Security Agency, in testimony before the House Select Committee on Intelligence in October 2014, noted that "there should be no doubt in our minds that there are nation-states and groups that have the capability to enter our systems ...and to shut down...our ability to operate our basic infrastructures...whether its generating power, moving water and fuel".

With greater deployment of information and communication technologies to enhance the operational efficiency of our energy infrastructure, we are also witnessing a rise in intentional, malicious challenges to our energy systems. We are seeing threats continually increase in numbers and sophistication. This evolution has profound impacts on the security and resilience of the energy sector, which is why we have made cybersecurity one of our highest priorities at DOE.

The QER released in April 2015 noted that over half of the cyber incidents reported to DHS's Industrial Control Systems Cyber Emergency Response Team in 2013 related to energy installations, with the next highest percentage in the low double digits. The reliance of all of our critical energy infrastructures on electricity places a very high premium on a reliable, modern and hardened electric grid, as well as our efforts to understand, develop and evolve our emergency response capability to ever-changing and evolving cyber-threats.

In addition, we are seeing a rise in extreme weather events that are projected to increase in frequency and intensity. These events have regional and at times national-scale impacts on our

energy infrastructures and highlight the need for comprehensive and coordinated emergency responses. According to the QER, billion dollar weather events, especially severe storms, have risen dramatically in the last 15 years and are indicators of the vulnerabilities of our energy systems to climate change and costly disruptions. They have stressed our response capabilities and resources and underscored the interdependence of our critical infrastructures. Recent DOE analysis examining the effects of climate change on energy infrastructure exposure to storm surge and sea-level rise found that vulnerabilities are likely to increase for many energy sector assets, including electricity. Under the highest sea-level rise scenario, by 2030 the number of electricity substations in the Gulf of Mexico exposed to storm surge from Category 1 hurricanes could increase from 255 to 337; by 2050 the number would rise to roughly 400.

Further, our energy infrastructures are increasingly interdependent and all are dependent on electricity. Hurricanes Katrina and Rita, for example, downed 85,000 utility poles, 800 distribution substations, and thousands of miles of transmission lines. On the worst day of these sequential events, the Nation also lost almost 30 percent of its refining capacity. Three weeks after Rita hit, oil markets were still short around two million barrels a day. Hurricane Sandy knocked out power to 8.66 million customers. More than nine days after the storm, product deliveries from terminals in New York Harbor had returned to only 61 percent of pre-storm levels, forcing industry to seek work-arounds to resume supplies. Also during Sandy, power outages shut down gasoline pumps, demonstrating the interdependencies of energy infrastructures and our growing reliance on electricity. Within one week of Sandy's landfall, less than 20 percent of gas stations in New York City were able to sell gasoline. In part, this was attributable to the absence of backup electrical generation at gas stations and is a further demonstration of the interdependencies of energy infrastructures and their growing reliance on electricity. Moreover, the lack of transportation fuel hindered the ability of emergency personnel to respond to the crises.

Sea level rise, severe weather and storm surge are not, however, only about electricity. The Gulf Coast region is home to nearly 50 percent of the Nation's refining capacity, so damage to liquid fuels infrastructure in this region can lead to significant impacts on much of the rest of the country, as the Gulf supplies oil products to the Northeast, Midwest, Mid-Atlantic, and South Atlantic regions. Land subsidence also is a widespread issue throughout the Gulf Coast (and Mid-Atlantic coastal areas). During the past century, global sea-level rise has averaged about 1.7 mm/yr, though the rate in the Gulf has been faster (at 5–10 mm/yr, in part due to subsidence). Between now and 2030, the average global sea-level rise could accelerate to as much as 18 mm/yr in worst-case scenarios.

Relatedly, aging energy infrastructure presents challenges to citizen safety as well as reliable supply of power. The recent Southern California Aliso Canyon gas leaks are a prominent example of the challenges the U.S. faces in managing a system that was built decades ago and that has not been upgraded. Another important example is our Strategic Petroleum Reserve (SPR), which remains an essential tools of energy emergency response as the United States is still a significant oil importer. Its value however – and how that value gets translated into its use and operations – is dramatically different than when it was created in the 1970s. U.S.

dependence on this infrastructure is high, and public and private investment in it should match its benefits in order to ensure the resilience and responsiveness of our energy grid of the future. Later in this testimony I will describe progress that we have achieved, working closely with this Committee and other Congressional partners, in advancing the maintenance and modernization of the SPR.

DOE's Emergency Authorities

The Department of Energy has its origins in the Manhattan Project and the Atomic Energy Commission. Under the Atomic Energy Act, DOE has authority to acquire, transport, store, and dispose of nuclear material in emergency and non-emergency situations. This extends to special nuclear material, source material, and byproduct material, and the Department has long performed vital emergency preparedness and response roles in this mission space. For example, at the Olympics in Rio today, we have responders on the ground to address potential radiological incidents, in conjunction with other Federal partners and Brazilian authorities. The Department has been strengthened by the capabilities provided in this domain, and we have drawn upon the competence they have built and maintained to begin to fulfill the newer responsibilities for which we are now organizing ourselves.

In the energy emergency domain, there is a range of authorities under which the Department can and does act. Statutes that govern DOE's emergency authorities include the Defense Production Act, the Energy Policy and Conservation Act, the Natural Gas Act, the Federal Power Act and the Natural Gas Policy Act.

DOE's authorities can be divided into categories: independent DOE authorities; DOE authorities requiring a Presidential finding; and authorities that require consultation with other agencies.

- The Department has independent authority to order temporary electricity connections and the generation and transmission of electric energy; make exchanges of crude oil or petroleum products from SPR, Northeast Gasoline Supply Reserve (NGSR), or Northeast Home Heating Oil Reserve (NEHHOR); assist entities to procure the necessary energy materials and services to maintain supply during an emergency or to restore their systems; control nuclear material and gather information.
- Emergency authorities requiring a presidential finding include grid security emergency orders to protect or restore the reliability of critical electric infrastructure; sales from the SPR, the Northeast Gasoline Supply Reserve, the Northeast Home Heating Oil Reserve; allocation of energy materials, services, and facilities in the civilian market; allocation and certain purchases of natural gas; and fuel switching electric power plants or major fuel-burning installations.
- DOE has a consultative role for Jones Act waivers and a concurrence role for fuel waivers.

Examples include:

Electricity Supply. The Department has used its independent authority to connect, temporarily, electricity lines to restore power (Hurricanes Ike, Katrina, and Rita), to require a power plant to continue operating to ensure grid reliability (Mirant Corp.'s Potomac River facility), to require specific transmission functions (Cross-Sound Cable Co. operation during the Northeast blackout), and to require generators to provide electricity when an Independent System Operator was otherwise unable to meet system demand (California energy crisis).

Petroleum Supply. DOE's exchange authority under EPCA authorized the loan of one million barrels from the SPR with Marathon Oil following Hurricane Isaac in 2012; 5.4 million barrels with Marathon, Placid, ConocoPhillips, Citgo and Alon USA following Hurricanes Gustav and Ike in 2008; 9.8 million barrels following Hurricane Katrina in 2005; and 30 million barrels in anticipation of a heating oil shortage in 2000. After Hurricane Sandy, the Department loaned approximately 120,000 barrels from NEHHOR to the Department of Defense's Defense Logistics Agency for use in emergency operations, primarily to fuel the vehicles of emergency responders.

If the President determines that a severe energy supply interruption exists, DOE can sell crude oil from the SPR, home heating oil (*i.e.*, ultra-low sulfur diesel) from the NEHHOR, or gasoline from NGSR. The last time a President authorized a sale in response to a domestic emergency was in 2005 after Hurricane Katrina when President Bush issued a finding of a severe energy supply interruption and directed the sale of 30 million barrels.

Natural Gas. If the President finds that a natural gas supply emergency exists or is imminent, the Department has been delegated authority under the Natural Gas Policy Act through Executive Order 12235 to allocate natural gas to meet priority uses and authorize certain natural gas purchases. This authority was used in 2001 (in combination with its Defense Production Act authorities) to respond to the California energy crisis.

Procurement Prioritization. In addition to authorities for responding to emergencies concerning the supply of electricity or liquid fuels, the President has delegated authority to DOE under the Defense Production Act to require performance on a priority basis of contracts or orders deemed "necessary or appropriate to promote the national defense." This authority was used during the California energy crisis of 2000-2001 to direct entities that had recently provided a utility with natural gas to continue to make similar volumes available to the utility on the same payment schedule as before.

Access to data for mission delivery: DOE has information-gathering authorities to compel energy sector entities to provide information that is relevant to DOE activities. For example, under section 13 of the Federal Energy Administration Act of 1974, the Secretary can order "[a]ll persons owning or operating facilities or business premises who are engaged in any phase of energy supply or major energy consumption" to make available energy-related information.
Power Marketing Administrations (PMA). The PMAs deliver power from federal hydropower assets, which can provide critical black start capabilities to reenergize the grid and support safe

nuclear plant shutdown. DOE has exercised these authorities in a variety of circumstances. In addition, three of the four PMAs, Bonneville Power Administration, Western Area Power

Administration and Southwestern Power Marketing Administration are active participants in utility emergency response programs. Crews and equipment are dispatched in support of emergency restoration and neighboring utilities.

Recent Emergency Authorities and Directives Related to Emergency Response

FAST Act. Last year, Congress recognized the growing complexities of the a rapidly evolving landscape and enacted important new energy security measures in the Fixing America's Surface Transportation Act (FAST Act) (P.L. No. 114-94). Part of the FAST Act provides DOE with a new authority to protect and restore critical infrastructure when the President declares a grid security emergency. This authority allows DOE to support the energy sector preparing for and responding to cyber, EMP, geomagnetic disturbance, and physical attack threats. These authorities do not apply, however, to natural disasters other than geomagnetic storms.

The FAST Act (Sec. 61004) also noted the critical nature of large power transformers to the electricity grid. The law requires DOE in consultation with Federal Energy Regulatory Commission (FERC), the Electricity Subsector Coordinating Council (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.

Balanced Budget Act of 2015. The 2015 Balanced Budget Act directly supports the findings of QER and states that "maximizing the energy security value of the SPR requires a modernized infrastructure that meets the drawdown and distribution needs of changed domestic and international oil and refining market conditions." The Act directs DOE to establish a SPR modernization program to protect the U.S. economy from the impacts of emergency product supply disruptions and that this program may include infrastructure and facilities to optimize the drawdown and distribution capacity of the SPR." Congress also authorized the sale of up to $2 billion in SPR crude oil sales to fund the SPR modernization program subject to appropriation.

Presidential Policy Directive 21. Presidential Policy Directive-21: Critical Infrastructure Security and Resilience identifies DOE as the Sector-Specific Agency (SSA) for energy infrastructure. Within the Department, the authority and responsibility of the SSA are assigned to Office of Electricity Delivery and Energy Reliability, and play a pivotal role in ensuring unity of effort between private and government partners, including the Department of Homeland Security, Department of Defense, and Federal Bureau of Investigation, to improve preparedness and response to all hazards in the energy sector.

As the Energy SSA, we serve as the day-to-day Federal interface for the prioritization and coordination of activities to strengthen the security and resilience of critical energy infrastructure. This involves building, maintaining, and advancing collaborative efforts with the energy sector to bridge federal programs for sharing situational awareness information, modeling impacts, assessing vulnerabilities, conducting exercises, and promote innovation and research.

Emergency Support Function 12. In addition to enhancing security and reslience through our role as an SSA, the DOE enhances security and resilience by serving as the lead agency for Emergency Support Function 12 (ESF-12) under the National Preparedness System's National Response Framework. As the lead for ESF-12, we are responsible for facilitating recovery from disruptions to the energy infrastructure. During a response operation, the Department works with industry and Federal, state, and local partners to:

- Assess disaster impacts on local and regional energy infrastructure;
- Coordinate the response to expedite restoration;
- Monitor and provide situational awareness of impacts; and
- Provide regular situational awareness updates to key decision makers in the Administration and our government and industry partners.

To achieve these operational priorities, the Department deploys responders who work directly with 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 throughout the Department, and at our interagency partners, to coordinate the appropriate assistance including waivers or special permits to expedite restoration efforts. Our response force is entirely voluntary, and we are training nearly 100 members of our staff to be prepared to deploy for all hazards contingencies.

Actions Taken Since 2014 to Increase Prevention, Resilience and Response Capabilities to Meet the Emerging Challenge

Over the past two years, the Deputy Secretary and I have led a deliberate effort to strengthen our emergency response capabilities and our critical partnerships with the energy sector. This included enhanced emergency preparedness/response collaboration with the Electricity Subsector Coordination Council (ESCC), the Oil & Natural Gas Subsector Coordinating Council (ONG SCC), and the National Petroleum Council (NPC) for strategic planning and operational exercising.

Partnering with Industry. DOE will continue to assist utility owners and operators and state and local officials across the country when hazards and threats emerge. With more than 80 percent of the Nation's power infrastructure privately owned and operated, coordinating and aligning efforts between the government and the private sector is the only viable path to increased resilience and effective emergency response.

When the power goes out, the local utility is the first to respond. Should any threat or emergency exceed jurisdictional resources or result in a Federal disaster declaration, DOE coordinates Federal resources as the lead as assigned under ESF 12. In collaboration with other Federal agencies, local governments, and industry, DOE facilitates access to impacted areas, actionable situational awareness information, regulatory waivers, and other tools to assist overwhelmed

jurisdictions. Together, we generate the actions that are needed to address the impact of the event and restore power.

Public-private emergency preparedness and response cooperation: Building on lessons learned from Superstorm Sandy, DOE has worked closely with the Electricity SubSector Coordinating Council (ESCC) – a national organization of major utility CEOs and industry associations – along with the Oil and Natural Gas Subsector Coordinating Council (ONG SCC) -- on a set of specific initiatives designed to strengthen the security and resilience of critical energy infrastructure. The Deputy Secretary and the ESCC meet at least three times per year to advance our work together, and focus on the sharing of relevant threat information (both before and during a crisis), conducting vulnerability assessments, developing and deploying new technologies, and exercising together.

For example, we are partnering with the ESCC and the Electric Power Research Institute (EPRI) on efforts to address the effects of an EMP attack. Additionally, we are working with the ESCC to help focus our R&D efforts and bring new technologies to market that will strengthen the security of the grid. In fact, we will be hosting a joint meeting of the ESCC and government officials this September at our Sandia National Laboratories to focus specifically on R&D issues. In addition, both the ESCC and the ONG SCC are part of a working group created by DOE and DHS that is focused on threats to the energy sector's manufacturing supply chain, and what government and industry can do together to improve the security of that supply chain. Most importantly, we work with the ESCC and the ONG SCC to prepare for, and respond to, major disasters or threats to energy infrastructure. Our partnerships span information sharing, supporting innovation, and exercising incident response.

The foundation of our partnerships is sharing appropriate information as true partners. Our success depends on it. One of the challenges here is speed. It is critical that all parties share information about dynamic threats expeditiously to protect our nation. DOE's solution is to provide tools and information to companies so that they can become aware of risks as soon as they're identified, and can take action.

The Cybersecurity Risk Information Sharing Program (CRISP) is a public-private partnership, co-funded by DOE and industry. The purpose of CRISP is to collaborate with energy sector partners to facilitate the timely bi-directional sharing of unclassified and classified threat information and to develop situational awareness tools that enhance the sector's ability to identify, prioritize, and coordinate the protection of critical infrastructure and key resources. CRISP leverages advanced sensors and threat analysis techniques developed by DOE along with DOE's expertise as part of the National Intelligence Community to better inform the energy sector of the high-level cyber risks. Current CRISP participants provide power to over 75 percent of the total number of continental U.S. electricity subsector customers.

Further, as part of the Administration's efforts to improve electricity subsector cybersecurity capabilities, DOE and industry partners developed the Electricity Subsector Cybersecurity Capability Maturity Model (C2M2) to help private sector owners and operators better evaluate their cybersecurity capabilities. The C2M2 evaluation helps organizations prioritize and improve cybersecurity activities. This is a comprehensive and credible approach that all energy sector

companies can use to improve their cybersecurity posture. DOE also released versions of the C2M2 for the oil and natural gas subsectors and for industry at large.

In addition, we have worked closely with the National Petroleum Council (NPC) to identify opportunities to strengthen emergency preparedness. At my request, the NPC conducted a comprehensive study on this topic and presented me, in December 2014, with an Emergency Preparedness Report, which included a number of recommendations for strengthening how the Department and the oil and natural gas industry work together to respond to emergencies. Over the past year, DOE has made progress implementing the recommendations contained in the report. For instance, DOE is now using the National Incident Management System (NIMS) and Incident Command System (ICS) to ensure that we can easily integrate with other emergency management organizations around the country. DOE's Infrastructure Security and Energy Restoration (ISER) team now has Energy Information Administration experts embedded in its emergency response organization, so they have the benefit of their insights into the oil & natural gas industry during emergencies. In addition, the Department is working more frequently with the oil & natural gas industry on disaster preparedness exercises. In fact, the NPC was one of the Department's key partners in the development of the Clear Path IV exercise, which I will describe shortly.

Partnering with the Federal/State/Local/Tribal Government. We are also supporting preparedness efforts by working to provide Federal, state, local, and tribal officials with programs and tools that help in their energy emergency preparedness activities, including, planning, training, tabletop exercises and research and development.
In early February, I signed an updated Energy Emergency Assurance Coordinators (EEAC) Agreement with the National Association of State Energy Officials, National Association of Regulatory Utility Commissioners, National Governors Association,, and National Emergency Management Association. 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 regular drills and exercises.

With the EEAC agreement in place, we are planning to enhance our state, local, tribal, and territorial governments program with robust training and exercising that brings stakeholders together to address planning for shared regional hazards. Many of today's lifeline sectors depend on reliable energy supplies. A vital element of providing uninterruptable energy is building resilience by developing regional plans to rapidly restore energy and identify specific needs to resolve energy disruptions. Lessons learned from these collaborations will be shared with other communities to leverage the effort across the Nation.

The President's FY 2017 Budget Request included $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.

This new program would be facilitated through competitive regional cooperative assistance awards to state and local partners. DOE would support planning, training, and exercising with expertise from across the enterprise including the HAMMER Federal Training Center and National Laboratories. The expertise and capability of the whole Department would be available to each consortium of 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.

Supporting Innovation. One of DOE's core missions is to support the innovation that will help us enhance our nation's energy security today and into the future. As the sector-specific agency in charge of supporting and facilitating the security of our electric grid, we are focused on growing our partnerships with academia and the private sector and leveraging the wide-ranging science and technology capabilities of our 17 National Labs in order to modernize our grid and make it more secure and resilient.

The Department continues to invest in long-term strategic R&D and testing capabilities throughout the National Laboratory complex to achieve these goals.

Since the 2003 Northeast blackout, DOE has been proactive in advancing technologies to modernize the grid by making it smarter and more adaptive to the challenges posed by a range of reliability concerns. Enhanced situational awareness and control capabilities enable grid operators to monitor the status of the grid, predict potential impacts of a threat, and respond accordingly to mitigate or recover from a threat.

For example, PNNL has been developing new modeling and simulation capabilities that leverage data streams from synchrophasor technology to help analyze and prevent disturbances from growing into wide area outages.

DOE has worked with utilities across the country to develop and deploy a network of more than 1,300 high-speed sensors across the nation's power grid to provide real-time data on the state of the grid. This network helps utilities better share information and quickly detect and mitigate local disturbances and prevent these problems from cascading into larger systems impacts.

DOE has also co-funded work with utilities in areas across the US to deploy high-speed communications and control systems that sense grid outages and re-direct power flows to minimize impacts on consumers. These systems also greatly help restore power after a disruption whether caused by a hurricane, tornado, or even cyber-related events.

Since 2010, we have invested more than $210 million in collaborative cybersecurity research and development projects among industry, universities, and our National Labs. Those investments have led to work such as the Honeywell-led "Role Based Access Control" project. This project created role based access control (RBAC) technology for a Honeywell product suite. This is an energy delivery control system used extensively within the oil and gas industry. The new technology limits access to the least needed to perform a given task, helping to reduce the risk of unauthorized access, including by an insider.

Sandia National Laboratory has a cybersecurity research partnership with Chevron to develop a technology that will change the control system configuration moment-by-moment. This is especially exciting because it will make it very difficult for an adversary to map the network or stage an attack. It also makes it easier for responders to isolate malicious actors if they do gain access.

In another project that DOE supports, Schweitzer Engineering Laboratories Inc. (SEL) partnered with Sandia National Laboratories (SNL) and Tennessee Valley Authority (TVA) to develop a commercial solution that detects tampering with the kinds of field devices that you see attached to utility poles, and further strengthens their cybersecurity by guarding against any unexpected cyber-activity. Thousands have been sold and are being used throughout the energy sector today in all 50 states.

Energy storage is another key technology the DOE is supporting that helps to increase grid resiliency. In additional to supporting greater deployment of variable renewable energy resources, energy storage technologies can keep customers and communities up and running during outages by supplying power to affected areas. When integrated into microgrids, another focus area of the Department, energy storage technologies can work in tandem with distributed generation and other energy resources to meet the needs of critical loads such as hospitals, first responders, and water supplies for an extended period of time. These essential services are critical to the health and safety of communities during large scale outages.

Large power transformers (LPTs) are grid components that are ripe for innovation. These critical assets can weigh hundreds of tons, are expensive, and are typically custom made with procurement lead times of a year or more. A large number of damaged transformers from a hazard could result in long-term outages that can cripple the economy. The QER recognized the risks associated with the loss of LPTs and recommended that DOE work with other Federal agencies, states, and industry to mitigate these risks, including assessing the development of one or more strategic transformer reserves. As noted, the FAST Act required DOE 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. 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. DOE's analytical approach is focused on identifying high voltage substations and LPTs that most affect the grid's performance if lost. We are also analyzing the availability of spare LPTs, determining the nature of events that could produce significant outages, identifying equipment options, including numbers and types, for provisional LPT replacement, optimizing number and locations of spare LPTs and identifying policy options to address these issues.

In addition, DOE is supporting modeling and testing of transformers to better understand their vulnerabilities to geomagnetic disturbances and electromagnetic pulses, informing new design requirements. A funding opportunity announcement released in June 2016 aims to stimulate innovative LPT designs that are more flexible and adaptable so they can be readily used in different locations. This solicitation promotes greater standardization which will increase the

ability to share transformers and accelerate recovery in the event of the loss of one or more of these vital pieces of equipment.

Another example of DOE innovation is EAGLE-I (Environment for Analysis of Geo-Located Energy Information), which 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 nationwide. 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.

In sum, our National Labs are powerful partners working with industry to secure our energy infrastructure. The Department has continued to build long-term strategic research and development capability at National Labs and academia. As a result, DOE helped create a national resource for experimental work in research and analysis of trustworthy power grid systems, both at the DOE Labs and universities.

The President's FY2017 Budget makes a strong first step toward our commitment to seek to double clean energy R&D funding under Mission Innovation, the international initiative to accelerate clean energy innovation. DOE's FY2017 request includes strong support for Mission Innovation, including a proposal for Regional Innovation Partnerships. DOE Mission Innovation work includes activities that support a strong foundation for addressing the infrastructure R&D needs discussed here, as well as activities that support the broader clean energy R&D needed for our economic, environmental and security goals.

Exercising Our Plans. Robust exercises are crucial to ensure industry and government are better prepared to work as a team during real world emergencies, such hurricanes, earthquakes, or cyberattacks. DOE leads preparedness exercises at the local, state, and national levels. In November 2015, for example, DOE led the Federal participation in the North American Electric Reliability Corporation's Grid Ex III, the largest electricity sector crisis response exercise ever. More than 350 government and industry organizations, as well as 4,500 participants played a role in testing and shaping the national response plan.

In April 2016, DOE led Clear Path IV in Portland, Oregon and Washington, DC. Clear Path IV was an interagency exercise focused on testing and evaluating energy sector response plans to address modeled impacts from a scenario depicting a Cascadia Subduction Zone (CSZ) 9.0 earthquake and tsunami. The devastation that would be caused by such an event was highlighted in a July 2015 *New Yorker* magazine article, titled "The Really Big One." As the *New Yorker* reported, a full-scale rupture of the subduction zone would cover a hundred and forty thousand square miles and impact an estimated seven million people. "When the next full-margin rupture happens," noted the *New Yorker*, "that region will suffer the worst natural disaster in the history of North America." These potential impacts help drive our decision to focus on the Cascadia Subduction Zone for the Clear Path IV exercise. Clear Path IV included representation from 10 Federal agencies, seven states, five local governments, 15 oil and natural gas companies, 18 electric utilities, six trade associations, and four state associations with more than 175 participants. Providing solutions to lessons learned will contribute to prepare the region to be

able to respond effectively to this kind of catastrophic event and improve DOE's ability to perform ESF #12 responsibilities.

Clear Path IV also served to enhance the energy sector's participation in Cascadia Rising, the national level exercise held in June 2016. Using the same Cascadia Subduction Zone scenario, the sector and DOE were able to test possible solutions to issues discovered during Clear Path and better inform our Federal partners what requirements are expected to restore energy. The collaboration between the two large, functional exercises are a model for the value of progressive exercise development.

Exercises like Clear Path and Cascadia Rising help the entire emergency management team – federal, state, local, and tribal governments, and industry – identify needs and resource requirements that will be required during an actual disaster. For instance, one of the lessons learned from Clear Path IV was the need to accelerate damage assessments immediately after a catastrophic event. The Department is working with DHS and Pacific Northwest National Laboratory to provide assessments through advanced algorithms that analyze aerial imagery, highlighting the role of science and technology solutions. To continue to fulfill our response mission, we innovate and provide practical solutions, including tools and new technologies, to facilitate quick energy restoration.

DOE Enterprise Solutions

Unique to DOE, we own critical assets in the sector we support. Our preparedness and response activities for our enterprise directly overlap with the broader energy sector with our PMA's, and this is why our internal and external emergency management activities must be unified. We are bringing together specialized talent across the Department including plants, sites, and our National Labs to strengthen how our team works together to respond to disasters and emergencies to our own assets as well as the broader energy sector.

Integrated Joint Cyber Coordination Center. We are further transforming the Department's cybersecurity culture and integrating cybersecurity coordination across the DOE enterprise through the Integrated Joint Cybersecurity Coordination Center (iJC3), which is funded by program contributions to the DOE Working Capital Fund. The iJC3 integrates cybersecurity across the Department in mutual, comprehensive defense of the DOE enterprise. The iJC3 will unify the breadth and depth of cyber technical expertise across DOE, remove redundancy, increase effectiveness, and holistically document and communicate cyber threats and leverage cyber capabilities DOE enterprise-wide.

The iJC3 is designed to both manage cyber risk across the Department using threat-informed cyber intelligence, and to mature and strengthen the Department's cyber posture and response. Previously independent cyber centers and specialized expertise will now be integrated in a collaborative, intelligence driven, enterprise distributed approach to cyber operations, defense, and response that engages DOE's full capabilities and protects the entirety of the DOE attack surface to include all program offices, national laboratories, plants, field offices, and the PMAs.

The iJC3 combines situational awareness of threats, operational status of networks, and indicators of known malicious activity to decrease discovery time and speed response time.

DOE Unified Command Structure (UCS). Last year, DOE established a Unified Command Structure (UCS) that has increased cooperation and coordination across the entire DOE enterprise – from our energy infrastructure team to our National Nuclear Security Administration, which responds to nuclear and radiological events. It ensures that the capabilities of the entire Department can be brought to bear in the face of any threat or scenario – regardless of whether that scenario involves one of our DOE facilities, requiring only internal coordination, or a large-scale incident involving portions of our Nation's energy infrastructure, which requires coordination with our industry and government partners.

Emergency & Incident Management Council (EIMC). To provide strategic guidance and direction for the UCS, we have also created an Emergency & Incident Management Council (EIMC) that is chaired by the Deputy Secretary and meets twice a month or more frequently when required. This Council serves as the primary DOE strategic coordination mechanism for senior Department leadership and enables us to prepare for and respond during significant emergencies that require the coordinated efforts of our entire Department or several of its components.

Consolidated Emergency Operations Center (CEOC). To advance the successful full implementation of our new approach that matches our evolving operational response mission, the Department has proposed the creation of a Consolidated Emergency Operation Center (CEOC) that will be designed for a full range of scenarios and incidents, and allow the UCS to operate in a single facility. When fully operational, the CEOC will eliminate DOE's fragmented emergency operations center system and provide a unified, inclusive, and effective emergency management enterprise modeled on best practices across the Federal government. We are currently working with the House and Senate Appropriations Committees to secure the funding and authority the Department needs to complete the development and eventual construction of the center.

Emergency Response Order 151.1. We have taken action to codify our emergency management enhancements and how they work together to achieve coordinated and comprehensive response activities in a recent revision to the Department's directive governing Emergency Response. The revised order 151.1 that I signed out earlier this month now has a dedicated section focusing on energy sector response, emphasizes an all-hazards approach to emergency management and planning, includes the EIMC as the senior-most body for emergency management, and embodies enterprise-wide stakeholder engagement to leverage unique capabilities across the Department, including our 17 national labs.

Deployable Crisis Expertise from National Labs

At the invitation of state and local authorities following the massive gas leak several months ago at the Aliso Canyon underground gas storage facility, DOE commissioned some of its National Laboratories to examine safety issues associated with existing oil and gas wells and related

underground storage facilities. This is the kind of on-call capability that we are able to field due to the deep bench of science and technology expertise located in our 17 National Labs.

Managing Federal Strategic Energy Resources.

The April 2015 Quadrennial Energy Review recommended that DOE invest to optimize the SPR's emergency response capability. It further stated that DOE should make infrastructure improvements in the SPR and its distribution systems to optimize the SPR's ability to protect the U.S. economy in an energy supply emergency." Implementing an effective and comprehensive modernization program will ensure that DOE will be able to move high volumes of incremental barrels of oil rapidly to successful bidders in case of a global supply disruption, thereby increasing supplies in global markets and enhancing the value of the SPR for meeting the Nation's strategic energy needs.

As noted, the 2015 Balanced Budget Act directly supports the findings of QER and states that "maximizing the energy security value of the SPR requires a modernized infrastructure that meets the drawdown and distribution needs of changed domestic and international oil and refining market conditions." The Act directs DOE to establish a SPR modernization program to protect the U.S. economy from the impacts of emergency product supply disruptions and that this program may include infrastructure and facilities to optimize the drawdown and distribution capacity of the SPR." Congress also authorized the sale of up to $2 billion in SPR crude oil sales to fund the SPR modernization program.

We are moving forward on the SPR modernization efforts. DOE has identified two specific projects that will make up the SPR modernization program:

- *Life Extension Phase II* –The aging SPR infrastructure is further strained with a challenging budget environment that has resulted in an extensive, growing backlog in the SPR's major maintenance project account. As a result, unanticipated SPR-related equipment failures are occurring and impacting the Reserve's operational readiness capability. The new life extension project will modernize aging SPR infrastructure through systems upgrades and associated equipment replacement to ensure that the Reserve is able to meet its mission requirements and maintain operational readiness for the next several decades. On October 30, 2015, Deputy Secretary Sherwood-Randall approved the mission need (Critical Decision 0), the first step in DOE's project management process, for the Strategic Petroleum Reserve, Life Extension Phase II Project.
- *Marine Terminal Distribution Capability Enhancements*—The SPR's effective distribution capability—the reserve's ability to deliver SPR oil to domestic consumers without displacing commercial oil shipments—is compromised by new patterns of oil supply and demand among U.S. oil producers and refineries and associated changes in the U.S. midstream, including overall capacity. This has reduced the ability of the U.S. to distribute incremental volumes of reserve oil to the domestic market during certain future oil supply disruption scenarios. The purpose of this project is to increase the effective distribution capacity of the SPR through the addition of dedicated marine

capacity. DOE has approved Critical Decision-0, Mission Need and we anticipate being able to commence work on the NEPA analysis in January 2017, pending ability to receive a congressional appropriation to commence crude oil sales this fall.

DOE will soon submit a report to Congress on DOE's long-term strategic review of the SPR, which will further articulate the need for modernization.

Conclusion

As you know, I was the Department of Energy (DOE) Under Secretary during the Clinton Administration. When I returned to DOE after a 13 year absence, I was struck by the imperatives of what is, in reality, a new and complex mission for the Department — energy infrastructure, resilience, reliability, security and emergency response with significant operational and cross-cutting aspects and requirements to ensure that these issues are effectively and appropriately addressed. The requisite energy system view is not reflected directly in DOE's organizational structure.

Let me deconstruct this concern by first defining the key goals of this mission area for energy infrastructure:

- **Reliability** refers to the ability of a system or its components to operate within limits so that instability, uncontrolled events, or cascading failures do not result if there is a disturbance, whether the disturbance is a disruption from outside the system or an unanticipated failure of system elements. Reliability is also used by industry to mean that a system's components are not unexpectedly failing under normal circumstances.
- **Resilience** refers to the ability of a system or its components to adapt to changing conditions and withstand and rapidly recover from disruptions. To the extent that actions improve a system's ability to withstand disruptions, they might be characterized as enhancing reliability, or resilience, or both. The ability to recover from a disturbance, however, is specific to resilience.
- **Safety** refers to achieving an acceptably low risk to life and health in the design, construction, operation, and decommissioning of a system. That level of risk is determined by taking into account the magnitude of potential consequences, the probability of those consequences occurring, and the costs of risk mitigation.
- **Security** refers specifically to the ability of a system or its components to withstand attacks (including physical and cyber incidents) on its integrity and operations. It overlaps, in part, with the concepts of reliability and resilience.

Each of these goals is related and has physical, temporal, operational, technology, regulatory and legal components. These all need to be understood – from a systems perspective -- for effective energy emergency response, for mitigating the costs of future emergency responses and for diminishing the overall need for emergency response over time.

We addressed many of these issues in the first installment of the Quadrennial Energy Review, which includes many analytically-supported recommendations on energy infrastructure

resilience, reliability, safety and asset security. Several of these recommendations are works in progress and some of them require new statutory authority.

Those that are in the process of being implemented and highly relevant to this discussion include:

- The development of comprehensive data, metrics, and an analytical framework for energy infrastructure resilience, reliability, and asset security: The purpose of this work will be to help inform, coordinate, set priorities for, and justify expenditures across Federal agencies to increase the resilience, reliability, and security of energy infrastructure.
- Analyzing the policies, technical specifications, and logistical and program structures needed to mitigate the risks associated with the loss of transformers as part of the Administration's ongoing efforts to develop a formal strategy for strengthening the security and resilience of the entire electric grid for threats and hazards. Approaches for mitigating this risk could include the development of one or more transformer reserves through a staged process.
- Undertaking updated cost-benefit analyses for all regions of the United States that have been identified as vulnerable to fuel supply disruptions. Additional or expanded Regional Refined Product Reserves could be supported, depending on the outcome of these studies.

QER recommendations that require additional authorities or appropriations that are highly relevant to the topic of today's hearing, and not discussed earlier, include:

- Funding of a multi-year program of support for state and tribal energy assurance plans, focusing on improving the capacity of states and localities to identify potential energy disruptions, quantify their impacts, and develop comprehensive plans that respond to those disruptions and reduce the threat of future disruptions. As part of these plans, states should also assess needs for backup electricity at retail gasoline stations along emergency evacuation routes.
- The establishment of a competitive grant program to promote innovative solutions to enhance energy infrastructure resilience, reliability, and security. A major focus of the program would be the demonstration of new approaches to enhance regional grid resilience, implemented through the states by public and publicly regulated entities on a cost-shared basis, incorporating lessons learned from new data, metrics, and resilience frameworks. An example of such a project is the NJ TRANSITGRID, which incorporates renewable energy, distributed generation, and other technologies to provide resilient power to key NJ TRANSIT stations, maintenance facilities, bus garages, and other buildings. Through a microgrid design, NJ TRANSITGRID will also provide resilient electric traction power to allow NJ TRANSIT trains on critical corridors, including portions of the Northeast Corridor, to continue to operate even when the traditional grid fails.
- Amending the trigger for the release of fuel from NEHHOR and from the Northeast Gasoline Supply Reserve so that they are aligned and properly suited to the purpose of a product reserve, as opposed to a crude oil reserve. The authorities of the President to

release products from RPPRs should be integrated into a single, unified authority; these two facilities operate currently under different authorities.

Implementing these recommendations will be critical for ensuring reliable, resilient safe and secure energy systems. They are not, however, enough.

As I noted, we continue to analyze organizational options to improve execution in this mission area in light of these complex, complicated, cross-cutting and evolving requirements. Emergency Management responsibilities that are currently assigned to other offices within the Department do not have separately identifiable budgets, and are dependent upon the ability to draw resources from other program budgets when needed to conduct emergency management activities.

Within our current budget of approximately $29 billion, funding for this mission area is embedded in the programs that execute it and there are two discrete budget line items that support specific aspects of emergency management --- a budget of $9 million for the ISER program in the Office of Electricity and a budget of $25 million for Emergency Management and Operations Center within the National Nuclear Security Administration (NNSA). The latter is primarily focused on radiological emergency issues but also plays a key role in energy-related emergency management. The President's FY 2017 budget proposed significant increases in both program budgets – ISER is proposed to increase from $9 million to $17.5 million, and the NNSA program is proposed to increase from $25.1 million to $34.8 million.

As part of our budget planning, I have initiated a comprehensive crosscutting budget review of our emergency management activities to ensure the Department is prioritizing it resources to effectively carry out its responsibilities going forward.

Intentional, malicious challenges and natural threats to our energy systems are on the rise. The manmade threats continually increase in sophistication. Our energy infrastructures are vulnerable to such threats, are aging, and increasingly interdependent and reliant on electricity. The electricity system end-to-end is the focus of the next major installment of the Quadrennial Energy Review, targeted for late this year.

DOE uses its expertise in transformative science and technology solutions to support and enhance our Nation's emergency response capabilities. Through our private and public partnerships, we apply these solutions to prepare for emergencies, mitigate risks, and expedite restoration and recovery from incidents impacting the energy sector. Looking ahead, Congress will be a key partner in ensuring that we strengthen our prevention and response capabilities.

Senator CANTWELL. Thank you, Mr. Secretary. Thank you for that testimony, and thank you for your work on the Quadrennial Energy Review—the plan for our energy infrastructure and where we are as a nation. That, I think, is a very good blueprint to start our discussions as a nation of where we need to go.

I would like to unpack that a little bit with your testimony. To me, reading the report, which is voluminous and is available for people online, I think they can get access to it or at least the key recommendations. It seems to me that as you tried to allude in your testimony, coming back to DOE after some absence——

Secretary MONIZ. Thirteen years.

Senator CANTWELL. Thirteen years, that we have several phenomenons going on. One is just this issue of we wanted to get off of foreign oil. We said we wanted to produce our own, and basically we had an infrastructure through the Gulf for importing oil and delivering it.

Now we are in a different situation and that, in and of itself, is causing competition on the rails, competition even between energy products. There are instances where oil is pushing off coal and coal and oil are pushing off agriculture products and a great deal of complexity. How would you characterize that shift in demand on our infrastructure? Significant? I mean, how would you characterize for the American people how big a challenge that change has meant to our infrastructure and some of these security issues?

Secretary MONIZ. Yes, and by the way, I'd like to, once again, thank you and congratulate you for reading the Quadrennial Energy Review on the floor of the Senate which was much appreciated.

The increased production of oil and natural gas in the United States has obviously been a major story in terms of our economy and also environment in the sense that the natural gas boom, in particular, has led to a displacement of higher carbon coal with lower carbon natural gas producing less CO2 emissions.

However, I mean, the big story with regard to infrastructure is not simply the scale, it's the fact that it's happening in different parts of the country. And so, it has changed flows completely.

I mentioned one example here already in terms of the petroleum reserve modernization. We have oil flowing in opposite directions in many of our distribution systems which is why we need to have a distribution system made for the current realities. Another is that it used to be that oil and products flowed from the Gulf elsewhere. Now we have considerable flows to the Gulf. Third, we have, still with oil, we have an addition, as you know very, very well, flows going east and west without established pipeline infrastructures and therefore, bringing in trains substantially.

Now it is true that oil by train has gone down very substantially nationally in this last year but not necessarily regionally, particularly here. But the magnitude of these changes, you mentioned up to 20 trains here in the Northwest. Just recently I was visiting one of the largest, the largest refinery complex on the East Coast in Philadelphia. And the changes are—clearly stress the system.

On the one hand, that one refinery was receiving four unit trains per day of Bakken oil. And now suddenly, it's dropped to one as they have resumed importing from Africa light oil. So, it's really

hard to keep up with these major changes and of course, as you have different infrastructure we need to build out in different ways.

I didn't mention natural gas but a similar thing there is that, again, all gas until a decade ago, fundamentally, flowed, you know, mostly out of the Gulf and some in the West in the Rockies, in New Mexico, in Colorado, et cetera. And now you have incredible production out of Pennsylvania, part of West Virginia and Ohio. The infrastructure, frankly, has not yet completely caught up to that. So these are big strains on the system, and we are feeling it.

Senator CANTWELL. I am glad that you characterize them as big strains because we definitely feel that way in the Northwest and this, in and of itself, I think, is a big shift. I also think that cyber is a big shift and change too, but we will get to that in a second.

But on this issue, one of DOE's responsibilities is, obviously, helping us understand the properties and characteristics of some of these products.

One of the things that you are working on is this issue of oil volatility. I am particularly concerned about the level of volatility in Bakken crude, because oil shipped from the Gulf basically doesn't have the same level of volatility when it is shipped. But with the advent of Bakken crude in the upper Midwest, we are seeing the volatility of the Reid Vapor Pressure, the pound per inch of pressure, well over 13 percent in some instances.

Can you elaborate on what DOE is doing to measure that volatility and what we should be looking for to make sure that we have a vapor pressure that is not going to impact the level of explosions and derailments and things of that nature that we have seen in some other areas of our country?

Secretary MONIZ. Well I certainly wish I could give you the final results of the study today but that still is, probably, about a year away.

Now, just again, to make, I mean, you know this, just to make it clear to everyone else that the, of course, the Department of Energy does not have the regulatory authorities but right at the beginning, and I think with a lot of encouragement as well from Congress, appropriately, we were asked to partner with the Department of Transportation, and we have, to explore the science involved in the transport of oil and frankly, it would apply as well to other flammable liquids because there are a lot of others that are transported as well and to try to understand the implications of that science for further steps that the Department of Transportation, for example, might take.

So the study is being carried out, is being led by Sandia National Laboratory. It is looking at the characteristics of the oil, volatility, as you say. And basically, I think, it's a question of looking at this particular crude oil which has quite of bit of dissolved gasses in it. So looking at that, at the qualities is very important.

However, it's also important to understand how and when, for example, the oil is sampled because as you go through different processes the characteristics can change so that's also part of what's being looked at. And this may be able to, hopefully, lead to some insights into how the sampling protocols are managed which then can impact whether further processing is required or not.

North Dakota as a state has taken some steps in terms of processing certain of the tight oils. And so, I think——

Senator CANTWELL. Well I don't think anybody in the Northwest——

Secretary MONIZ. Yeah.

Senator CANTWELL. Wants to leave it up to the State of North Dakota.

Secretary MONIZ. No, no.

Senator CANTWELL. To figure out what the standard is, so——

Secretary MONIZ. No, so our job is to, right now, try to do a thorough job on the science and engineering aspects. That will include going to combustion tests in this next phase at Sandia which has, by the way, a long history of doing combustion field tests and studies.

And then I'd love to be able to accelerate it, but science takes time and it's probably going to be a year until we have the final results. Then those have to be translated at state and federal levels into further action.

Senator CANTWELL. I noticed that a Sandia National Lab report found that "currently used methods for assigning crude oil classifications are often inaccurate" and that there is not scientific agreement on the volatility of crude oils, like Bakken crude.

How do you think we might be able to build scientific consensus, that we might be able to get more discussion going about this issue because clearly I view this as a resistance by those who think they can just ship Bakken crude on the cheap. I note that Wall Street will not finance a deal with Bakken crude at this level. They require that it has to be nine percent vapor pressure. As I said, other incidents of this kind of shipment never exceeded 13 percent. Now we are sitting here arguing over whether volatility matters or not. What can we do to get the rest of the scientific community, while we are doing this review, to help in the discussion so that we don't end up with your report and then we are still doing this leg work after that 12-month period of time?

Secretary MONIZ. Well first of all, I think the report you're referring to was the Phase One report from Sandia which was basically a literature review. It was not original work but bringing together literature. And again, I believe the focus there was on the fact of the large amount of dissolved, non-condensable gasses. So that was the characteristic, I think, they were seeing. And that's exactly what is driving now them in their actual scientific work in terms of the characterization.

I just really can't give a clear answer in terms of what one might do in terms of the, you know, I mean, prior to having the results for you. I understand there's a tension between getting the science done right and doing it as fast as one can, but doing it right. Obviously the desire to take action clearly was not that long ago when the derailment in the Columbia Gorge happened just in June, I think it was.

And so, again, nationally there's been a decrease in oil shipments by rail. That has not been the case in the Northwest.

And it's also the case that, I think to be fair, I think the railroads, some of the railroads for sure, have made some pretty substantial investments really over the last year. Issues you referred

to earlier, in fact, about commodity competition in the railroads, I mean, that was a very stressful period in 2014/2015 when the, I think, frankly the whole system was, again, taken by surprise at the rapid increase in the demand for trains for transporting oil.

I think that's been somewhat sorted out in terms of the commodity issue. But your issue in terms of any intermediate regulation, I mean, the Department of Transportation clearly has taken some steps in terms of rail cars, speed, speeds in different places and the like. And yet, we still seem to have some of these derailments, presumably caused by track issues.

Senator CANTWELL. We are only going to ask you to swim in your lane today.

Secretary MONIZ. Yeah.

Senator CANTWELL. As it relates to——

Secretary MONIZ. Right.

Senator CANTWELL. Helping us on the energy verification. But I will say that this issue, as it relates to commodities, I don't think is over, and I do think that your work on the Quadrennial Energy Review shows that our infrastructure cannot meet this level of demand in shipment without pushing product off.

Again, this is probably not something that DOE can solve as it relates to——

Secretary MONIZ. Right.

Senator CANTWELL. These issues immediately. But this issue of——

Secretary MONIZ. Right.

Senator CANTWELL. Assessing our infrastructure, assessing our needs and, as you say, can shift at any moment as well.

Secretary MONIZ. Yeah, it's——

Senator CANTWELL. As it relates to source.

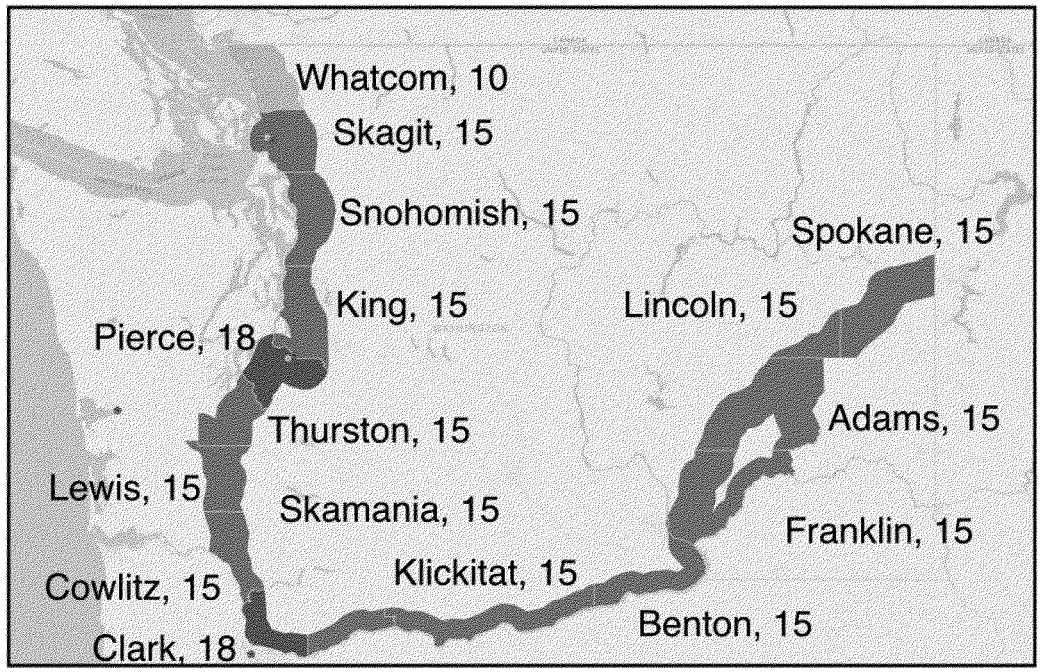
But I go back to what you commented on that this is a pretty big shift for the United States of America. We wanted energy independence. Well, we've got it. But now we have our own safety and security issues right here in the Northwest with a 10,000 percent increase in the amount of oil train traffic coming through here.

When we have a city council in Spokane who is saying we are going to fine a train for coming through period, that is their ballot measure. We have a chart here.

[The information referred to follows:]

Oil trains moving through Washington

Trains per week by county



Source: Department of Ecology, State of Washington, Spill Maps

Secretary MONIZ. Yeah, I was going to say it's——

Senator CANTWELL. Just to take a second.

So Bakken Oil comes from the upper Midwest, but it goes through every major metropolitan area. It goes through Spokane, down through the Gorge which is a very challenging, scenic area into the Columbia River. So the rescue operations are very challenged. Through Clark County, Vancouver and then up through here and all the way up to refineries. We have four refineries in the north part of our state. It is hitting every major city on those 20 trains per week.

I am sure North Dakota producers probably think that they are going through a very remote, rural area of their state, across also very remote, rural parts of the North United States, but that is not what happens when they get to Washington because of the Cascades.

Secretary MONIZ. Yeah.

Senator CANTWELL. They have to go through every major——

Secretary MONIZ. Yeah.

Senator CANTWELL. As somebody said on one of my recent trips to Spokane, just about everybody in Spokane lives two blocks from the railroad tracks. I mean, that is their view of how close the oil shipments are.

This issue for us has become very front and center with every mayor, city council and community in our state as it relates to this safety and security issue. So we will leave this.

Secretary MONIZ. Yes.

Senator CANTWELL. To the next panel.

Secretary MONIZ. Yeah.

Senator CANTWELL. And discuss it more with you later.

Secretary MONIZ. If I may just add?

Senator CANTWELL. Yes.

Secretary MONIZ. Just that first of all, I think, it's very clear and the President has certainly been very clear in saying that we need to invest in our infrastructure. I mean, and we need to invest in infrastructure that is reliable, safe and resilient for the 21st century and not for the 20th century.

Secondly, in terms of the movement of commodities and, again, you know this very well from the Quadrennial Energy Review, it is also issues like inland waterways where tremendous investments are needed to move commodities around.

Senator CANTWELL. Well and I hope we can, with your work, we are separately pushing the Department of Transportation to make an interim finding about the volatility. We think they should be doing something about it now but we are also going to double our efforts working with you to make sure that we are getting as much scientific information as possible. As you said, the big shift means that we need to invest in infrastructure. But the big shift also means we need to stop and say, is this safe enough for transport?

The 10,000 percent increase is voluminous throughout the West Coast. You could have this hearing in Oregon or California and you would have the same discussions. You would have the same city councils, the same people proposing resolutions on this.

So I think we need to make sure that we are making it safe as well, and we will continue to work with your other cabinet partners to make sure that we are getting that message across.

Before we invite the next panel up though, I do want to talk to you about the cyber issue, this whole issue of a unified command.

I don't know how you would characterize this as a shift in our nation, but again, I would consider it a pretty big shift because now here we are, a big energy source. Electrification was always important, but now it is networks and handheld devices and smart appliances and all sorts of things, all connected to a grid that could, all of a sudden, be a target of a major attack.

So when you talk about your unified command structure and the challenges of that, who are the partners? Where would the single entity be? How do you process information on a daily basis?

Secretary MONIZ. Well, the unified command structure is broader than cyber that was for the entire, our entire emergency response assets. And it's not a physical location, other than when there is an emergency in the emergency operations center control room that, again, we are trying to—which historically in the Department of Energy has always been run by the Nuclear Security people because of our long standing need to respond to nuclear incidents. But we think that we need to really integrate response across our threat spectrum. That would include nuclear but it includes energy infrastructure, cybersecurity and the like.

Now within cybersecurity we now have this integrated Joint Cybersecurity Coordination Center. I may have missed a C, iJC3. And that has been—the point person, I'm putting them together, has been the CIO but working with all the cyber-relevant actors, and I want to emphasize that does include the intelligence activity.

But very importantly, this involves bringing in the laboratory experts, the PMA experts. So the ideas that we are saying that the cybersecurity is really an enterprise-wide problem, and we need to have them all.

It's a virtual team. It's not a physical center but it's a virtual team bringing together all the best assets to address a cyber challenge. And I think you alluded to it, the last data I saw in 2013, but over half of the cyber incidents reported were on energy infrastructure. So, it's a tremendous problem that we have.

Senator CANTWELL. Okay.

Secretary MONIZ. What we are doing is we are trying to bring together, again, all of our assets.

Senator CANTWELL. Okay.

Secretary MONIZ. It would be helpful to have this more unified operations center, yeah.

Senator CANTWELL. Because you are talking about both DOD, I am assuming, and our other federal agencies involved in security efforts working in coordination.

Secretary MONIZ. And DHS, we do a lot with DHS, in particular. Yeah, DHS has got a major role here. So we work with them.

Senator CANTWELL. Again, where would you characterize this as a shift in energy policy, this electrification of our economy and the challenge of cyber?

Secretary MONIZ. If we kind of change subjects, but relevant to this. If we think about our pathway toward deep de-carbonization,

let's say on a midcentury time scale, there are two elements that, to me, are, kind of, part of any possible solution.

One is real progress on the demand side, energy efficiency. We're not going to get there without real demand side progress. But we're also not going to get there without, essentially, a very deep de-carbonization of the electricity sector and therefore, an expansion of the electricity sector's role in other parts of the economy, like transportation, for example, because then it will be drawing upon an essentially carbon-free system.

So, electricity is only going to become more and more central to all of these issues. And that, of course, brings us to the whole threat spectrum, including cyber which we know is a very, very significant issue. And frankly, as that system itself becomes more and more, I would say, technologically complex it's going to have increasing distances, for example, to bring, you know, renewables over large distances. It's going to have distributed generation; it's going to have storage; and, it's going to have a whole new layer of detectors, sensors, control systems, maybe distributed decision-making to be able to balance this entire system.

That's all great. It offers new services. It can support the Internet of things with everything hooked up, but obviously it also opens up vulnerability, especially in the cyberspace.

So I think that's what we're going to have to face and frankly, stay ahead of the attack spectrum. So it's a huge priority for us and I think for the country.

Senator CANTWELL. Thank you.

Secretary MONIZ. Yeah.

Senator CANTWELL. Well thank you, Secretary Moniz. I think what I am going to ask you to do is come up and join me, if you will, up here and we will proceed to the second panel of witnesses. That will also give Secretary Moniz a chance to have a little opportunity on the other side of the dais here.

[Laughter.]

Senator CANTWELL. And ask some questions of our witnesses on these subjects and maybe even get into more of a discussion on some of the challenges that we face.

Secretary MONIZ. Sure.

Senator CANTWELL. I see General Lowenberg out in the audience. Thank you for being here.

There are many others who are here today in the audience who are responsible for these kinds of shifts and changes and are doing good work in the Northwest. So thank you all for coming and talking about how we, as a region, are developing some of the solution services and networks that are needed.

I introduced the panel before, but I think we are going to start with Mr. Robert Ezelle, who is the Washington Military Department's Director of the Emergency Management Division. We will then go to Ms. Stephanie Bowman, who is with the Port of Seattle; Mr. John Hairston, who is with the Bonneville Power Administration; Mr. Scot Rogers from F5; Mr. Carl Imhoff from the Pacific Northwest National Laboratory; and Dr. Lynn Best, who is with Seattle City Light.

With that, Mr. Ezelle, please lead us off.

STATEMENT OF ROBERT EZELLE, DIRECTOR, WASHINGTON STATE EMERGENCY MANAGEMENT DIVISION

Mr. EZELLE. Afternoon, Madam Chair and Secretary Moniz.

For the record, my name is Robert Ezelle, and I'm the Washington Military Department's Director of the Emergency Management Division. I greatly appreciate the opportunity to speak with you today about two significant events that could impact our energy infrastructure.

First are the impacts that could occur to Washington State and the Pacific Northwest following a magnitude 9.0 earthquake on the Cascadia Subduction Zone. Second, as we've already been hearing, are some potential consequences to the energy sector from a cyber event.

A rupture of the Cascadia Subduction Zone (CSZ) will cause catastrophic damages all along the West Coast from British Columbia to Northern California. Damage from a CSZ rupture will greatly exceed damage from any natural disaster our nation has seen to date.

Estimates are that our transportation infrastructure, communication systems, energy distribution, water, sewage and our health care system will be severely compromised or inoperative. Bridges will collapse, roadways will be rendered impassable, the coast will be cut off from the I-5 corridor and Western Washington will be cut off from Eastern Washington.

We anticipate electric power failing across the region from significant impacts to both transmission and distribution systems. Restoration will be time consuming with urban areas being without power for weeks to months and outlying areas potentially requiring a couple of years before power is restored.

Pipelines delivering fuel, oil and national natural gas will be compromised and possibly destroyed. This means we'll be left with only the fuel on hand in vehicles or storage tanks that have not ruptured. This has immediate implications to the response to a Cascadia event as fuel will be required for generators, response vehicles and a host of other needs.

However, the most significant effect or impact of a CSZ rupture will be to the people themselves. Depending on the time of year we could see upwards of 10,000 fatalities from the resulting tsunami and from collapsed buildings and landslides. We estimate we will need to provide food and water to upwards of a million people immediately following the earthquake. That number will increase with each passing day as individual and family preparedness supplies are exhausted.

We conducted a major exercise, Cascadia Rising 2016, from June 7th to June 10th of this year. We gained valuable lessons learned that will engage our preparation activities for years to come. But perhaps the most important thing we drew from the exercise was perspective.

Our overarching priority immediately following a CSZ event will be to provide for the life safety and life sustaining needs of our populous. Each day that passes increases the vulnerability and the need of our residents. This puts a critical imperative on restoring our basic infrastructure starting with transportation, communica-

tions and electric power but it also greatly emphasizes the need for individual and family preparedness.

Electric power is the enabling component of our 21st century lives. It also has key interdependencies with other critical infrastructure industries such as water and waste water services, natural gas supply and delivery and telecommunications technologies of all types. Without electric power our infrastructure cannot operate.

The same goes for fuel distribution. A CSZ event will damage the major pipeline for delivery of jet fuel as well as natural gas pipelines and will, of course, disrupt transportation networks making fuel delivery by truck to existing depots all but impossible. And without fuel, our response efforts will grind to a halt.

As I've emphasized, power and fuel are key to a successful response and recovery. Therefore, their provision and restoration has to be a top priority for us all.

CR'16 emphasizes the need for detailed response or continuity of operations planning. This includes all levels of government from local through state to federal, non-governmental organizations and private industry so that essential services can continue to be provided in the event of a disaster.

Additionally, our lifeline sectors whether publicly or privately owned must work toward building resiliency. A resilient infrastructure can either withstand a major disaster or can be quickly restored in days or weeks rather than months or years.

We've been talking about the catastrophic and the need to develop strong plans to build resiliency into our critical infrastructure. I'd like to touch on a couple of hazards, and we've already spoken about them today, that are not perhaps at the scale of a catastrophic event, but could have severe local or widespread consequences.

The first of these is the transport of the crude oil by rail. We've seen graphically what can go wrong if there's an incident involving an oil train. This highlights the need for detailed planning, again, at all levels of government so that communities and states are prepared to respond when an incident occurs, such as the one near the Town of Mosier back in June.

The need for the same level of planning also is required for cyber threats. In Washington State we've been hard at work there as well conducting cyber planning across the community of stakeholders. Organic within the Washington National Guard structure is a cyber protection unit whose capabilities can assess or assist with assessment and recommendations concerning industrial control systems. They have the expertise, relationship, security clearances and the credibility to partner and collaborate with the ICS community toward cyber preparedness.

Most recently in Washington State in a proof of concept demonstration, our National Guard worked successfully with the Snohomish County Utilities District to assess their systems and provide them key suggestions on how they can harden their infrastructure against cyber penetration and exploitation.

Madam Chair, I'd like to close by just thanking you for your tremendous support for our National Guard, particularly the attempts to stand up at a schoolhouse to address some of the cyber

vulnerabilities and then, of course, your long-term support of the National Guard.

This concludes my testimony, and may I answer any questions?

[The prepared statement of Mr. Ezelle follows:]

Written Testimony of
Robert Ezelle, Director, Washington State Emergency Management Division

U.S. Senate Committee on Energy and Natural Resources
Field Hearing
Monday, August 15, 2016 at 11:30 a.m. PDT in Seattle, Washington

Good morning Madame Chair and members of the committee. I greatly appreciate the opportunity to speak with you today about two significant events that could impact our energy infrastructure. First are the impacts that could occur to Washington state and the Pacific Northwest following a magnitude 9.0 earthquake on the Cascadia Subduction Zone. Second are the potential consequences to the energy sector from a cyber event.

A rupture of the Cascadia Subduction Zone will be catastrophic all along the West Coast – from British Columbia to Northern California. In 2001, when the Nisqually earthquake struck Western Washington, the ground shook at a magnitude 6.8 for about 45 seconds. The damage from this quake totaled more than one billion dollars. Unreinforced masonry buildings crumbled, and damage to our infrastructure was extensive. A magnitude 9 quake on the CSZ will result in ground shaking in the urban area of Western Washington at about the same magnitude as Nisqually, but for a duration of up to 6 minutes. The duration of shaking will increase expected damages by many orders of magnitude. In fact, damage from a CSZ rupture will greatly exceed damage from any natural disaster our nation has seen to date.

A Homeland Security Infrastructure Threat and Risk Analysis Center (HITRAC) Study, completed in 2011, estimates that our transportation infrastructure, communication systems, energy distribution, water, sewage, and our health care system will be severely compromised or inoperable. For example, in Western Washington, bridges will collapse and roadways will be rendered impassible. The coast will be cut off from the I-5 corridor and Western Washington will be cut off from Eastern Washington.

When it comes to electric power, we anticipate it failing across the region from significant impacts to both transmission and distribution systems. Restoration will be time consuming, with urban areas being without power for weeks to months and outlying areas potentially requiring a couple of years before power is restored.

The pipelines delivering fuel, oil and natural gas will be compromised, and possibly destroyed. This means we will be left with only the fuel on hand in tanks that have not ruptured, be it at local gas stations, agency fuel depots, or with the military. This has immediate implications to the response as fuel will be required for generators, response vehicles and a host

of other needs. Once local stocks are depleted, all required fuel will have to be transported into the region over the degraded or destroyed transportation infrastructure. I could go on and on about the impacts in all of the lifeline infrastructure sectors. It's a grim picture, but all the underlying things we rely on to live our 21st century lives will be gone.

However, the most significant impact of a CSZ rupture will be to the people themselves. Depending on the time of year, we could see upwards of ten thousand fatalities from the resulting tsunami and from collapsed buildings and landslides. The HITRAC study estimates we will need to provide food and water to upwards of one million people immediately following the earthquake. That number will increase with each passing day as individual and family preparedness supplies are exhausted.

We conducted a major exercise, Cascadia Rising 2016 (CR 2016), from June 7th to 10th of this year. We gained valuable lessons learned that will engage our preparation activities for years to come. But perhaps the most important thing we drew from the exercise was perspective.

Our overarching priority immediately following a CSZ event will be to provide for the life safety and life sustaining needs of our populace. The fundamental challenge of a Cascadia Subduction Zone earthquake is that we, as a nation, must mount an effective response over a destroyed infrastructure against a ticking clock to avert a humanitarian catastrophe. We do not have the luxury of time to get assistance and commodities flowing into the area. Each day that passes increases the vulnerability and need of our residents. This puts a critical imperative on restoring our basic infrastructure starting with transportation, communications, and power.

If we are to provide an effective response, detailed, integrated planning must take place in advance of the event. An earthquake is fundamentally different from a major hurricane in that one can see the hurricane coming well in advance and take the appropriate steps. An earthquake is a low frequency, no-notice, high consequence event that we must plan for the eventuality of it happening. Stakeholders at every level of government from local, tribal, county, state, and federal, as well as private industry and non-governmental organizations must come together to address the fundamental challenges that will face us when the CSZ next rips. It is only through this detailed level of planning that we will be able to build a modicum of preparedness that will help us to mount a successful response.

In prioritizing our planning activities for the next several years, we must look to the following:

1. Development of strong continuity of operations plans by all levels of government, the private sector, and non-governmental organizations. Contingency planning looks at what could be impacted by various hazards and develops plans so that essential functions can continue in the event of a disaster.
2. Prioritizing the restoration of electric power and fuel
3. Assurance of lifeline transportation routes into the affected area. This includes airfields, roads, rail and ports. This is absolutely critical if we are to mount an effective response and recovery.
4. Planning to meet basic life safety and sustaining needs. This includes mass care and medical.

5. Transitioning from a pull system of logistics to a push system in which needed materials and supplies are automatically pushed into our area following a major disaster.
6. Ensuring the availability and redundancy of public safety and emergency management communications
7. Individual and family preparedness

While this list is not all-encompassing, it gets to the heart of the basic challenge we have before us – taking care of the people who will be dramatically impacted by the disaster and ensuring that government and critical infrastructure are able to provide their essential services.

I'd like to comment about planning for electric power restoration. Power is the enabling component of our 21st century lives. It also has key interdependencies with other critical infrastructure industries such as water and wastewater services, natural gas supply and delivery, telecommunications technologies of all types. Without electric power our infrastructure cannot operate. Power is key to a successful response and recovery. Therefore, electric power restoration has to be a top priority for us all.

Much of our electric power infrastructure is privately owned; other parts of it are publicly owned or fall within cooperatives. Regardless of ownership, it is imperative that the industry has strong foundational Continuity of Operations plans so that essential services can continue to be provided in the event of a disaster and that the industry works toward building resiliency. A resilient infrastructure can either withstand a major disaster or can be quickly restored in days or weeks rather than months or years. Additionally, I would like to make a case that as part of our planning efforts, the electric power industry and stakeholders across the whole of community plan together to establish power restoration priorities and develop strategies so that basic life sustaining needs can be met and the engine of recovery can be jump-started.

CR16 showed the importance of the delivery of all types of fuel and petroleum products, including jet fuel, as well as providing for storage depots. A CSZ event will damage the major pipeline for delivery of jet fuel, as well as natural gas pipelines, and will of course disrupt the transportation networks making fuel delivery by truck to existing depots impossible. Without fuel our response efforts will grind to a halt. This is an area we need to focus on collectively in our lessons learned.

I'd like to close by making a plea. A CSZ rupture threatens the entire nation. Without power or the ability to move supplies and services, our entire nation's economy is at risk. Given that, it will take resources from every level of government to mount an effective response. As a state and nation, we must invest in resiliency. As an emergency manager, I would much rather see us invest in our electric power transmission and distribution systems and our fuel pipelines ahead of a disaster so when it strikes, they're resilient and survive, reducing the need for even larger investments and last-minute workarounds after the event. It will take investments by private industry and at all levels of government if we are to truly build resiliency in our region.

Organic within the Washington National Guard structure is a cyber protection unit whose capabilities can assist with assessment and recommendations concerning Industrial Control Systems (ICS). They have the expertise, relationships, security clearances and the credibility to partner and collaborate with the ICS community toward cyber preparedness. Most recently, in

Washington state in a proof of concept demonstration our National Guard worked successfully with the Snohomish County Public Utility District to assess their systems and provide them key suggestions on how they can harden their infrastructure against cyber penetration and exploitation.

Senator CANTWELL. Thank you, thank you.
Ms. Bowman.

STATEMENT OF STEPHANIE BOWMAN, COMMISSIONER, PORT OF SEATTLE (WASHINGTON)

Ms. BOWMAN. Good afternoon, Senator Cantwell and Secretary Moniz. My name is Stephanie Bowman, a Commissioner with the Port of Seattle. Thank you for the privilege of being here this afternoon.

The Port of Seattle owns and operates facilities that play a critical role in facilitating the nation's trade. Our marine cargo facilities under the management of the Northwest Seaport Alliance are the fourth largest container load center in the country. Our port literally supplies goods to businesses and homes throughout the nation.

On the aviation side, Seattle/Tacoma International Airport (SeaTac) served 42 million passengers in 2015 and is the fastest growing, large hub airport in the country. Additionally, SeaTac is a primary air cargo gateway for the Pacific Northwest facilitating the export of high value, time sensitive goods to Asia.

The Port of Seattle facilitates—facilities serve as a lifeline to the residents of Alaska and Hawaii and any disruption in port operations due to a natural disaster would have serious consequences for those states.

Alaska is especially dependent on our infrastructure with more than 80 percent of all water-borne containerized traffic that goes to Alaska moves across the terminals at the Port of Seattle.

Given the critical role that the Port of Seattle plays in the regional and national economy ensuring that our facilities are resilient in the case of a disaster is a charge that my colleagues and I on the Port Commission take very seriously. A strong federal partnership is critical, and I'm grateful for the attention that you're giving to this issue today.

Port infrastructure will be essential to the regional response in the event of a large scale emergency. SeaTac airport is anticipated to be a hub for relief efforts and our maritime facilities will also support the response and recovery missions assuming that they are still operable.

Disruption of flight operations at SeaTac will send a ripple effect throughout the country's air transportation system given that our airport's role as a hub for both national and international flights, particularly our connection to Asia. Most importantly, it could cripple our collective ability to respond to disaster.

I wanted to speak briefly about the Port of Seattle's emergency response planning. The Port of Seattle and our partners at the Port of Tacoma use nationally recognized best practices and utilize an all hazards approach to plan for and respond to any number of different emergency scenarios. Consistent application of these practices is reinforced through our robust and systemic training and exercise program that validates our ability to meet our responsibilities to the region.

In the case of earthquakes our contingency planning is based on the risk associated with strong to major earthquakes. Our seaport facilities, as you know, Senator Cantwell, are at greater risk than

the airport because they were built on liquefaction zones and are more susceptible to a tsunami.

Given the strain that will be placed on the first responders in a disaster, we expect that we will need to be self-sufficient with our emergency response at the airport or seaport for at least 14 days.

The airport, on the other hand, will be more likely capable of handling moderate to full disaster relief within 24 to 72 hours, the level of operations at the airport with a focus of federal and military entities in the recent Cascadia Rising exercise that Mr. Ezelle just mentioned.

Understandably, the magnitude of any quake will impact our ability to resume operations. A primary factor in successfully responding to an event is the effective coordination between the dozens of entities involved. That is why exercises such as Cascadia Rising are vital to enhancing the regional resilience. We are not going to be able to operate resilient airports and seaports without a strong partnership with the Federal Government.

In addition to the critical role it will play in responding to a disaster, we are also dependent on the Federal Government to help fund our preparedness efforts and I wanted to speak to that very briefly. We ask that funding levels for these programs be maintained and that funding be awarded directly to local jurisdictions including ports. While there are few federal grant programs that focus on preparedness, the Port Security Grant Program is currently the main source of federal funding for all ports for an all hazards investments.

However, many tyeps of projects necessary to support a comprehensive preparedness effort are ineligible under the Port Security Grant Program. Given this, the Federal Government, we hope, will—should consider creating critical infrastructure resiliency grant program and a national strategy to help funding decisions with prioritizing the nation's gateway ports which are at greater risk.

Finally, I wanted to close, shift gears for just a few moments and close with a personal mention of my experience in Mosier, Oregon and just let you know that I was at Mosier in the—for the rail train derailment, and I'm happy to answer any questions. It had a pretty significant impact on my personal view in terms of both emergency preparedness but most importantly in terms of the response. And after the panel is through I'm happy to answer any questions about that experience.

In closing, the Port of Seattle recognizes that our infrastructure impacts the national economy and has a unique role to play during a crisis. We stand ready to strengthen our partnership with the Federal Government, including the Department of Energy, to safeguard our critical infrastructure and protect our communities.

I'm happy to answer any questions.

Thank you.

[The prepared statement of Ms. Bowman follows:]

Testimony of Stephanie Bowman, Commissioner, Port of Seattle
US Senate Committee on Energy and Natural Resources
Seattle Field Hearing
August 15, 2016

Introduction

Good morning Senator Cantwell and Secretary Moniz. I am Stephanie Bowman, Commissioner of the Port of Seattle. Thank you for the privilege of being here with you today.

The Port of Seattle owns and operates facilities that play a critical role in facilitating the nation's trade. Our marine cargo facilities, under the management of the Northwest Seaport Alliance, are the fourth largest container load center in the US, with more than half of our import volumes bound for the Midwest distribution centers. The imported cargo coming through our port literally supplies goods to businesses and homes throughout the country.

On the aviation side, Seattle-Tacoma International Airport is the nation's 13th busiest passenger airport, serving over 42 million passengers in 2015. Sea-Tac is currently the fastest growing large hub airport in the country, experiencing double-digit growth for three consecutive years. We are the region's gateway to Asia, providing a critical link for our international businesses such as Boeing, Microsoft and Amazon. Additionally, Sea-Tac also is the primary air cargo gateway for the Pacific Northwest, facilitating the export of high value, time sensitive Washington State agricultural products to Asia, such as our world-renowned cherries.

Port of Seattle facilities also serve as a lifeline to residents of Alaska and Hawaii, and any disruption in port operations due to a natural disaster would have serious consequences for these states. Alaska is especially dependent on our infrastructure. Of all waterborne containerized traffic between Alaska and the lower 48 states, over 80% moves through our terminals, including food, medical supplies, building materials and other necessities.

Given the critical role that the Port of Seattle plays in our region's and nation's economy, ensuring our facilities are resilient in the case of a disaster is a charge my colleagues and I take very seriously. We rely on assistance from the federal government to help support our preparedness efforts, and I am grateful for the attention you are giving to this issue.

Airports and seaports are critical infrastructure

We all should be concerned about the resiliency of the infrastructure at our nation's gateway ports. Port infrastructure will be essential to the regional response in the event of an emergency. Sea-Tac Airport is anticipated to be a hub for relief efforts, and maritime facilities also will support the response and recovery mission assuming they remain able to operate. Disruption of flight operations at Sea-Tac Airport would send ripple effects throughout the country's air transportation system, given our airport's role as a hub for both national and international flights, particularly our connection to Asia. Most importantly, it could cripple our collective ability to respond to a disaster.

Port of Seattle's emergency planning

While there is no question we can always continue to improve, the Port of Seattle and our partners at the Port of Tacoma are maritime industry leaders in emergency preparedness. We utilize an all-hazards approach to plan for and respond to the various impacts that could result from any number of different emergency scenarios. Our methods are based on nationally recognized best practices, such as the National Incident Management System, Incident Command System and the National Response Framework. Consistent application of these best practices is reinforced throughout our systematic training and exercise program that validates that we have the right organizational infrastructure, equipment and systems in place to meet our responsibilities to the region.

In the case of earthquakes, our contingency planning is based on the risks associated with strong to major quakes. Seaport facilities are at greater risk than the airport because they are built on liquefaction zones and are susceptible to the seiche effects of a tsunami. Even if our marine terminals are able to continue operations, it is likely road and rail access to the waterfront would be obstructed. Given the strain that will be placed on first responders in a disaster, we expect we will need to be self-sufficient with our emergency response at seaport facilities for at least 14 days. Sea-Tac Airport does not face these same risks and is expected to withstand a strong to major quake fairly well. The airport likely would be capable of handling moderate to full disaster relief flight operations within 24 to 72 hours. Restoring the airport's operational capability to this level was emphasized by federal and military entities in the recent Cascadia Rising exercise.

I am confident we are taking the right steps toward achieving resiliency and that we have a strong foundation for mounting an effective recovery effort. However, it is important to note that depending on the magnitude of the quake, restoring normal operations could take anywhere from days to years.

Our first priority in the event of an earthquake and other disasters is the protection of human life, including the safety of employees, tenants, and customers. Simultaneously we would establish communications with Unified Command and other responding agencies and stakeholders. Next on the list is damage assessments, infrastructure stabilization and risk assessment for what could happen in subsequent aftershocks, with the primary goal being to resume operations to support relief efforts. We also would confirm the sustainability of response operations by obtaining food, water, and shelter.

By far the most important factor in successfully responding to an earthquake is effective coordination between the dozens of entities that will be involved, and this is a core of our emergency planning. That is why exercises such as Cascadia Rising are vital to enhancing regional resilience. Cascadia Rising allowed us to test our internal communication backup systems and multi-jurisdictional coordination across the port, city, county, and federal levels.

Another benefit of Cascadia Rising was that it highlighted opportunities for improvement. We have already started taking steps to address these issues. But one thing that is clear is that we are not going to be able to operate resilient airports and seaports without a strong partnership with the federal government.

In addition to the critical role it will play in responding to a disaster, we also depend on the federal government to help fund our own individual and regional preparedness efforts. We ask that federal funding levels for these programs be maintained and that funding be made available directly to the jurisdictions that manage and maintain critical transportation infrastructure, including ports.

While there are a few federal grant programs that focus on preparedness, the Port Security Grant Program is the main source of federal funding for ports for all-hazards investments. The PSGP can be used for emergency preparedness to a limited extent, but its true purpose is reducing the risk of terrorism and criminal activity. Many types of projects necessary to support a comprehensive preparedness effort are ineligible for the program. For example, funds cannot be used to develop training or for firefighting equipment, let alone for other critical, expensive projects such as seismic retrofitting. The PGSP could be amended to allow for more resilience applications, although funding would need to be increased in order to avoid undermining port security priorities.

Even better, I ask the federal government to consider creating a critical infrastructure resiliency grant program and a national strategy to help guide funding decisions.

Personal experience at Mosier

I would like to shift gears for a moment and mention briefly a personal experience that has helped shape my perspective on emergency preparedness. I have a home in the small town of Mosier, Oregon, and was one of the first on the scene when 16 rail cars carrying crude oil from North Dakota derailed on June 3rd, with four of those rail cars catching fire. Witnessing the response to this disaster, and knowing first-hand how catastrophic it could have been, has greatly influenced my thoughts on first response efforts. While I realize this isn't a primary focus of this hearing, I'm happy to answer any questions you have about this experience.

Even though this was a relatively small event compared to some of the scenarios we have discussed today, I would characterize it as significant. It has solidified my commitment to the principle of resiliency, and I believe emergency preparedness needs to be a priority for all jurisdictions, large and small.

Closing

In closing, at the Port of Seattle we recognize the decisions we make have implications for the national and regional economy and that our infrastructure has a unique role to play during a crisis. The Port of Seattle stands ready to strengthen our partnership with the federal government, including the Department of Energy, on ensuring we are doing everything we can to safeguard our critical infrastructure and to protect our communities.

Thank you for inviting me to participate today. I look forward to your questions.

Senator CANTWELL. Thank you, Commissioner.
Mr. Hairston, thank you. Welcome.

STATEMENT OF JOHN HAIRSTON, CHIEF ADMINISTRATIVE OFFICER, BONNEVILLE POWER ADMINISTRATION, U.S. DEPARTMENT OF ENERGY

Mr. HAIRSTON. Thank you.
Ranking Member Cantwell, Secretary Moniz, I appreciate the opportunity to testify today. My name is John Hairston. I'm the Chief Administrative Officer with Bonneville Power Administration.

Bonneville is a federal power marketing administration within the United States of America Department of Energy which markets electric power from 31 federal hydroelectric projects and some nonfederal projects in the Pacific Northwest. Bonneville operates and maintains an extensive high voltage electricity transmission system that integrates with every major electric utility in the Pacific Northwest as well as California and Canada.

Bonneville plays a critical role in responding to disaster affecting the region's electricity grid. In my testimony today I will describe how Bonneville is protecting the electricity infrastructure and how it's preparing to respond to a potentially massive Cascadia Subduction Zone earthquake.

Bonneville has hardened its electricity transmission system and is investing in seismic related research for more than 20 years. We began assessing which areas and components of the power system and most vulnerable to significant damage from the earthquake and other natural disasters. These comprehensive assessments from—having informed Bonneville's multifaceted, seismic mitigation strategy and has allowed it to prioritize where and when to upgrade and reinforce critical facilities and equipment.

Electricity will be critical to the region's recovery in the event of a natural disaster. Whether continuing to harden facilities, protecting power system equipment or researching the latest seismic mitigation tools and technology, Bonneville takes this responsibility of shoring up its assets extremely serious.

As Chief Administrative Officer I oversee Bonneville's Office of Security and Continuity of Operations which implements the Bonneville-wide program for physical, personnel, information and infrastructure security, emergency management and continuity of operations. This Office ensures Bonneville is resilient and able to quickly recover from events that cause operational impacts. With that goal in mind, Bonneville recently actively participated in two emergency planning activities.

In April 2016 Bonneville participated in the previously mentioned Clear Path IV energy-focused disaster response exercise hosted by the Department of Energy, Office of Electricity Delivery and Energy Reliability. The exercise scenario consisted of a magnitude 9.0 earthquake and subsequent tsunami occurring along the 700-mile-long Cascadia Subduction Zone causing considerable damage to Washington, Oregon and Northern California. The exercise scenario was designed to test regional dependencies in the energy sector. The exercise was a positive step forward in developing the national energy response capability and served as an important forum for building and strengthening linkages between government

and industry. The exercise also identified improvements that can be made with respect to coordination between critical components that must work together to quickly respond to a catastrophic event. Bonneville will continue to work with the DOE Office of Electricity and its regional energy partners to address gaps that were identified by participating in this exercise.

In 2016, June 2016, Bonneville participated in the largest FEMA exercise ever conducted in the region. Building from the energy sector-specific Clear Path IV, Cascadia Rising also simulated a 9.4 magnitude earthquake. For our part Bonneville held a four-day exercise with its core emergency response personnel and table top exercises for field staff across the service territory. Bonneville tested its plan and transferred complete control of its electric grid to a site hundreds of miles from the potentially affected area.

Cascadia Rising and Clear Path IV proved to be successful exercises for Bonneville in so far as they allowed employees and workers to practice their training and test our implementation plans. Bonneville will continue to participate in these types of emergency response exercises so we become well practiced and operationally ready to face real life situations.

As the owner and operator of 75 percent of the region's high voltage electric transmission system, Bonneville knows investments in both physical security and cybersecurity is vitally important to safely and reliably operating the electric grid in a modern world.

We recently embarked on a multi-million-dollar physical security program for critical substations concentrating on perimeter security. This effort includes upgrading fencing, lighting and improving detecting systems, cameras and alarms and has led to more comprehensive security design standards for wherever substation facilities are upgraded or new substations facilities are constructed.

In the past two years we've increased our staffing around cybersecurity from 12 employees to over 40 employees and implemented a 24/7 cybersecurity operations and analysis center. Bonneville has two dedicated teams to cybersecurity. One team performs forensics and intelligence, incident response and 24 hours a day handling of these type of issues. The other team performs offensive research and security assessments. Bonneville even conducts offensive cyber operations against our own network to test, drill and improve our detection and response.

In conclusion, our investments to make Bonneville a more resilient organization from hardening and protecting our infrastructure to the time that we spend to take, to prepare and practice how we respond to a disaster will ultimately help us limit damages to our electric power system and help the region more quickly recover from a major disaster.

Ranking Member Cantwell, Secretary Moniz, thank you for this opportunity to testify. I happily submit my written testimony for the record and respond to any questions you may have.

[The prepared statement of Mr. Hairston follows:]

STATEMENT OF

JOHN HAIRSTON

CHIEF ADMINISTRATIVE OFFICER

BONNEVILLE POWER ADMINISTRATION

U.S. DEPARTMENT OF ENERGY

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

U.S. SENATE

AUGUST 15, 2016

Ranking Member Cantwell, Members of the Committee, I appreciate the opportunity to testify today. My name is John Hairston. I am the Chief Administrative Officer of the Bonneville Power Administration (Bonneville). Bonneville is a Federal power marketing administration within the United States of America, Department of Energy, which markets electric power from 31 Federal hydroelectric projects and some non-Federal projects in the Pacific Northwest. Bonneville operates and maintains an extensive high voltage electricity transmission system that integrates with every major electric utility in the Pacific Northwest, as well as with California and Canada.

Bonneville plays a critical role in responding to any disaster affecting the region's electricity grid. In my testimony today, I will describe how Bonneville is protecting its electricity infrastructure and how it is preparing to respond to a potentially massive Cascadia Subduction Zone earthquake.

Bonneville's Seismic Mitigation Program

Bonneville has been hardening its electricity transmission system and investing in seismic-related research for more than 20 years. We began by assessing which areas and components of the power system are most vulnerable to significant damage from an earthquake and other natural disasters. These comprehensive assessments have informed Bonneville's multi-faceted seismic mitigation strategy and have allowed it to prioritize how, where and when to upgrade or reinforce critical facilities and equipment. In recent years, Bonneville has seismically hardened a control center, substation control houses (including hardening nonstructural components such as battery backup systems), microwave buildings, a telecommunications building and a critical equipment storage facility, and updated its seismic design policy for new facilities. We have also distributed our most critical functions among geographically diverse operating centers staffed 24/7 with independent information technology systems. This helps ensure Bonneville can operate these critical control functions solely from one site if necessary.

Protecting high-voltage transformers, an essential component to operating the electricity system, is also a top priority. In 2014, Bonneville completed a decades-long project,

which involved anchoring approximately 500 transformer, reactor and station service units in high-risk seismic hazards areas west of the Cascades, from the southern Oregon border to Canada.

Bonneville also was the first in the country to deploy state-of-the-art base isolation technology designed to protect high-voltage power transformers during an earthquake. Base isolation is a growing method for protecting structures during an earthquake. As part of a multiyear research project funded by its Technology Innovation Office, Bonneville partnered with the Multidisciplinary Center for Earthquake Engineering Research (MCEER) at State University of New York at Buffalo to test the performance of base isolation technology and then install it on an operation unit. In September 2013, Bonneville moved to the deployment phase of the project, where we outfitted a 460-kilovolt transformer with four friction pendulum base isolators. The isolators consist of two 24-by-24 inch steel square plates that are stacked with an articulated slider between the concave surfaces so that during an earthquake the plates and slider move relative to each other and provide isolation between the ground motion and the transformer. Eventually, Bonneville could retrofit transformers in high-risk areas with base isolators and make it a standard for transformer units installed in new substations. Base isolators could be a relatively inexpensive upgrade that could make the Northwest power system less vulnerable and save the region hundreds of millions of dollars in replacement costs.

Electricity will be critical to the region's recovery in the event of a Cascadia earthquake. Whether hardening facilities, protecting power system equipment or researching the latest seismic mitigation tools and technologies, Bonneville takes its responsibility of shoring up its assets extremely seriously.

Preparing for Disaster

As the Chief Administrative Officer, I oversee Bonneville's Office of Security and Continuity of Operations, which implements the Bonneville-wide program for physical, personnel, information and infrastructure security; emergency management; and continuity of operations. This office ensures Bonneville is resilient and able to quickly

recover from events that cause operational disruptions. With that goal in mind, Bonneville recently actively participated in two emergency planning activities.

Clear Path IV

In April 2016, Bonneville participated in the Clear Path IV Energy-Focused Disaster Response Exercise hosted by the U.S. Department of Energy (DOE) Office of Electricity Delivery and Energy Reliability (OE) in Portland, OR, and Washington, DC. The exercise scenario consisted of a magnitude 9.0 earthquake and subsequent tsunami occurring along the 700-mile long Cascadia Subduction Zone (CSZ), causing considerable damage to Washington, Oregon, and northern California. The exercise scenario was designed to test regional dependencies in the energy sector.

Several objectives were identified for this exercise including examining energy sector roles and responsibilities within response plans such as the DOE Energy Response Plan, State Emergency Management Plans, State Energy Assurance Plans, and industry response plans and prioritizing the restoration of energy systems.

The two-day exercise began in Portland with an examination of the regional response operations. Bonneville staff engaged in the tabletop exercise that examined the field coordination required to restore electric power and fuel supplies in the affected states. The afternoon session included a workshop to develop a framework for power restoration and recovery.

The exercise was a positive step forward in developing the national energy emergency response capability and served as an important forum for building and strengthening linkages between government and industry. The exercise also identified improvements that can be made with respect to coordination between the Federal Emergency Management Agency (FEMA) and other critical federal agency components that must work together to quickly respond to a catastrophic event. Bonneville will continue to work with DOE OE and its regional energy partners to address the gaps that were identified by participating in this exercise.

We believe DOE helps most with coordination and assistance with the acquisition and logistics of out-of-region resources (such as fuel, major critical spare parts and air assets to evaluate grid condition). We have learned from experience that during real-time events mutual assistance is helpful and welcomed. For example, Bonneville provided mutual assistance in response to Superstorm Sandy and sent transmission line crews and maintenance equipment to the east coast by military transport. During the event, DOE through Emergency Support Function (ESF) #12 helped expedite support by working with Department of Transportation and Department of Defense to facilitate inter state movement of large maintenance equipment.

Cascadia Rising

In June 2016, Bonneville participated in the largest FEMA exercise ever conducted in the region. Building from the energy sector specific Clear Path IV exercise, Cascadia Rising simulated a 9.0 magnitude earthquake generated by the CSZ fault. The exercise was designed to stress the capabilities and infrastructure of cities and counties as well as state, tribal and Federal resources, many whom were active participants in the exercise, to respond to a large-scale disruptive event.

As part of Cascadia Rising, Bonneville held a four-day exercise with its core emergency response personnel and two-hour table-top exercises for field staff across our service territory. Certain concessions were necessary to make such an intricate and ambitious exercise work. The scenario created by FEMA was modified by Bonneville's continuity of operations staff to stress our transmission and power systems. One of the principal Bonneville-specific scenarios in the exercise was that no power would be available west of the Cascade Mountains. Bonneville exercised four separate Incident Management Teams, one on each day, simulated to be physically located in Spokane, Wash. These teams worked in close coordination with our Spokane-area Munro Control Center dispatchers to prioritize and execute initial assessment and response. A multi-year project which BPA completed to alternate facilities, technology systems and documentation of power and transmission activities, allowed Bonneville to effectively transfer complete

control of the electric grid to a site hundreds of miles from the potentially affected area. In addition, we have worked with our Federal partners (US Army Corps of Engineers and US Bureau of Reclamation) to develop a Coordinated Continuity Plan to manage basic operations of the Columbia and Snake rivers from east of the Cascades if operational capability from the Portland area is interrupted.

If the events of the Cascadia Rising exercise actually occur, Bonneville recognizes that it cannot simply rely upon its own capabilities to resolve an enormous crisis spread across multiple states. Conducting successful response operations in the aftermath of a Cascadia Subduction Zone disaster hinges on the effective coordination and integration of governments at all levels – cities, counties, state agencies, Federal officials, the military, tribal nations – as well as non-government organizations and the private sector. That is one reason why the Cascadia Rising exercise so important - it helped train and test this whole community approach to complex disaster operations together as a joint team.

With this in mind, Bonneville, along with Western Area Power Administration, Southwestern Power Administration and DOE developed an operational plan to respond to a national energy emergency. In addition, Bonneville is part of the Western Region Mutual Assistance Agreement with 44 other utilities to facilitate the rapid exchange of resources when responding to regional emergencies. A recent effort has produced an additional coalition with the utilities in our service territory as well as utilities in the 12 western states and two Canadian provinces (British Columbia and Alberta) known as the Western Regional Mutual Assistance Group. This entity exists to facilitate the coordination of resources in the western United States and Canada to fulfill requests for a regional or national response event.

The purpose of the Cascadia Rising exercise was to test our coordinated plans, uncover issues and learn how to better manage through highly stressful situations. We learned a lot and identified some gaps. At the end of the exercise, Bonneville planners gathered recordings from exercise evaluators, participant feedback forms and field personnel

discussions and identified key lessons learned. The following initial recommendations have emerged:

1. Continue to understand and utilize the Incident Command System (ICS) within Bonneville by deploying an implementation plan and determining how different workgroups would interact with, report to, or make requests of the Incident Management Team.

2. Continue to understand the unique challenges of Cascadia Subduction Zone Earthquake scenarios by identifying geographically dispersed critical resources, determining equipment needs and training for field crews, and exploring complex and technical damage assessments across large areas susceptible to aftershocks.

3. Continue to enhance Bonneville internal and external coordination and collaboration.

4. Minimize the potential for communication and information loss by testing and training on the various types of communication equipment available, adding amateur radio to expand interoperable communications capability, and assessing lessons learned from the impact of losing critical business systems.

5. Continue to improve Bonneville's exercise program by developing and refining the test, training and exercise program, utilizing continuity coordinators to act as subject matter experts on planning teams to assist in developing realistic, increasingly more complex exercises and prioritizing employee participation.

6. Continue to develop the Incident Management Team by enhancing the current recruitment program to expand the pool of potential team members and their geographic diversity, and increasing the level of training and number of exercises for incident management team members.

Cascadia Rising and Clear Path IV proved to be successful exercises for Bonneville insofar as they allowed employees and workgroups to practice their training and test our implementation plans. Bonneville will continue to participate in these types of emergency response exercises so we become well-practiced and operationally ready to face a real-life situation.

Our Most Important Asset

We are nothing without our people – our employees need to be ready and available to provide the critical response activities necessary to keep the Federal Columbia River power grid operational. In any disruption, from a winter storm to the Cascadia Subduction Zone Earthquake scenarios, the sooner employees feel family and property are safe, the sooner they can return to work. For the last four years, Bonneville has emphasized personal and family preparedness throughout the workforce by conducting interactive presentations that provide useful tips on topics such as family reunification plans, building an emergency kit or managing stress. We have monthly emails to employees with simple, incremental things they can do each month to enhance their readiness - on-line awareness training, and an emergency notification service to provide timely information or instructions – on-line resources for additional information and we notify each employee in writing annually of their responsibilities in a disruptive incident.

CONCLUSION

Our investments to make Bonneville a more resilient organization, from hardening our infrastructure to the time that we take to prepare and practice how we respond to disaster will ultimately help us limit damages to our electric power system and help the region more quickly recover from a major disaster. This concludes my prepared remarks. I would be happy to respond to any questions from the Committee.

Senator CANTWELL. Thank you.

Mr. Rogers, welcome, and thank you for being here.

STATEMENT OF SCOT ROGERS, EXECUTIVE VICE PRESIDENT & GENERAL COUNSEL, F5 NETWORKS, INC.

Mr. ROGERS. Thank you very much for having me, Senator. Good afternoon.

For the record my name is Scot Rogers. I'm the Executive Vice President and General Counsel of F5 Networks, Inc.

Again, I want to thank the Senator and the Secretary for giving me this opportunity to testify and provide information to this Committee and be a part of this panel to discuss topics, we at F5 believe are of critical importance to the safety and prosperity of our country. But I'd first like to give you a little background on my employer, F5 Networks.

We're a worldwide leading developer and provider of software-defined application services. We are based here in Seattle with over 4,300 employees worldwide and applications have become the gateway to critical and sensitive data and services. And our mission is to help organizations deliver the most secure, fast and reliable applications to anyone, anywhere, at any time.

Our offerings include software products for network and application security, access management and a number of other network and application services. In conjunction with our customers and partners across a variety of fields and industries, we are closely watching the evolution of cyber threat landscape for organizations in the 21st century.

As the Senator and the Secretary referred to repeatedly during their presentations that this concept of innovation and innovations driven here in the Northwest are creating new challenges for the energy infrastructure. Disruptive technology trends are dynamically altering the threat landscape for organizations operating in today's world. The explosion of new software applications, the emergence of cloud computing and the Internet of things, combined with an increasingly mobile workforce are leading to dissolution of the traditional security perimeter.

Legacy security architectures are no longer adequate to protect against the evolving threats posed by cyber criminals, activists and state-sponsored espionage and sabotage. To borrow from a commonly used analogy, the traditional security architectures were akin to building a castle and a moat to secure the king. The castle architectural relies upon utilizing traditional network firewalls and other devices on the network perimeter to monitor and block suspicious traffic at the boundary of the network.

In today's world envision the software application as a very mobile president traveling the world, who needs the protection of its Secret Service bodyguards as he travels. As the network perimeter or in this analogy, the castle walls, become more and more irrelevant industries need to focus on protecting the software applications that drive their business and manage their critical infrastructure as well as verifying the identities of those users who access those applications.

The leading technology industry firm, Gardner, estimates that 90 percent of security investment is target at securing this network perimeter but only 28 percent of the attacks are focused there.

Conversely, only ten percent of the security investment is focused on securing the software application itself while 72 percent of attacks are from application vulnerabilities and stolen user credentials.

Our U.S. energy sector is not immune to these types of evolving threats. In particular, the Internet of things with the inclusion of new Smart meters, home power generation devices with connections back into the power grid and the various interfaces of the scattered networks creating a unique set of challenges. All these new Smart devices are run by new and innovative software applications whose access needs to be managed and whose data needs to be protected.

And where will the state of emerging energy applications be developed and reside as the world moves to a cloud centric model? Again, these applications are being built and hosted outside the castle walls.

All of these unsecured new devices create new threat factors of attack that must be mitigated. The world of our energy infrastructure, it isn't the theft of data that is the biggest threat, but a disruption of service or destruction of its means of delivery.

In December of last year hackers disabled portions of Ukraine's power grid leaving over 200,000 residents without power for several hours. In the attack on the Ukraine's power grid, the hackers used compromised user credentials to remotely log in to the SCADA network that controlled the grid. In this instance remote workers weren't required to use two factor authentication for remote log in which allowed the attackers to hijack their credentials and gain crucial access to the systems that control the breakers for the system.

The Department of Energy has taken steps to help secure our nation's energy infrastructure with the issuance of its Energy Sector Cybersecurity Framework Implementation Guidance containing recommendations for implementation of the NIST framework for improving critical infrastructure of cybersecurity.

In the ever evolving world of technology it is important that organizations stay vigilant to address these exponential threats presented by new technologies and to avoid complacency. A strong focus on protecting not just the networks interconnected to our infrastructure but the software applications that operate and support that infrastructure as well as the users accessing those software applications it's critical to the safety and security of our nation's energy sector.

Through utilization of web application firewalls, multifactor authentication and identity federation for secure remote access, with consistent policy-based access controls and security data analytics on user behavior, the energy sector can evolve its security architecture to address the dissolution of the network perimeter.

With that I would like to acknowledge the Committee and thank them for giving the opportunity to recognize these threats that are emerging and note that I'm happy to answer any questions that the Committee may have, as well as to provide any follow-up materials.

[The prepared statement of Mr. Rogers follows:]

Scot F. Rogers
EVP & General Counsel
F5 Networks, Inc.

Testimony before the Senate Committee on Energy and Natural Resources
Field Hearing on Oversight of the Department of Energy's Functions and Capabilities to respond to Energy Related Emergencies, Including Impacts to Critical Energy Infrastructure

Thank you Senator and Mr. Secretary for giving me an opportunity to provide information to this Committee and be a part of this panel to discuss topics we at F5 believe are of critical importance to the safety of our country.

I would first like to give you a little background on my employer, F5 Networks, a worldwide leading developer and provider of software-defined application services. We are based here in Seattle with over 4,300 employees in offices around the world. Applications have become the gateway to critical and sensitive data and our mission is to help organizations deliver the most secure, fast, and reliable applications to anyone, anywhere, at any time. Our offerings include software products for network and application security, access management and a number of other network and application services. We also offer distributed denial-of-service (DDoS) protection, application security and other application services on our cloud-based platform. In conjunction with our customers and partners across a variety of fields and industries, we are closely watching the evolution of the cyber-threat landscape for organizations in the 21st century.

Disruptive technology trends are dynamically altering the threat landscape for organizations operating in today's world. The explosion of new software applications, the emergence of cloud computing and the internet of things (IoT) combined with an increasingly mobile work force are leading to the dissolution of the traditional security perimeter. Legacy security architectures are no longer adequate to protect against the evolving threats posed by cyber criminals, hacktivists and state sponsored espionage and sabotage. To borrow from a commonly used analogy, traditional security architectures were akin to building a castle and a moat to secure the king. This castle architecture relies upon utilizing traditional network firewalls and other devices on the network perimeter to monitor and block suspicious traffic on the boundary of the network. In today's world, envision the software application and data associated with that application as a very mobile president who needs the protection of his secret service body guards as he travels the world. As the network perimeter—or in this analogy the castle walls--become more and more irrelevant, industries need to focus on protecting the software applications which front-end their critical and sensitive data, that drive their business and manage their infrastructure as well as verifying the identities of those users who are accessing those applications. The leading technology industry research firm Gartner estimates that 90% of security investment is targeted at securing the network but only 28% of the attacks are focused here. Conversely, only 10% of security investment is focused on securing the software application while 72% of attacks are from application vulnerabilities and stolen user credentials.

Our U.S. energy sector is not immune from these types of evolving threats. In particular, the Internet of Things (IoT) with the inclusion of new smart meters, home power generation devices with connections back into the power grid, and the various interfaces of the Supervisory Control and Data Acquisition networks that control the grid (SCADA networks) create a unique set of challenges. All of these new smart devices are run by new and innovative software applications whose access needs to managed and whose data need to be protected. And where will these emerging energy software applications be developed and reside as the world evolves to a cloud centric model?

All of these unsecured new devices create new threat vectors of attack that must be mitigated. In the world of our energy infrastructure, it isn't the theft of data that is the biggest threat, but disruption to the service or destruction of its means of delivery. On December 23rd of last year, hackers disabled portions of Ukraine's power grid leaving over 200,000 residents without power for several hours. In the attack on Ukraine's power grid, the hackers used compromised user credentials for workers logging remotely into the SCADA network that controlled the grid. In this instance, remote workers weren't required to use two-factor authentication for remote login, which allowed the attackers to hijack their credentials and gain crucial access to systems that controlled the breakers for the system.

The Dept. of Energy has taken steps to help secure our nation's energy infrastructure with the issuance of its *Energy Sector Cybersecurity Framework Implementation Guidance* containing recommendations for implementation of the National Institute of Standards and Technology (NIST) *Framework for Improving Critical Infrastructure Cybersecurity* (NIST, 2014). In the ever evolving world of technology, it is important that organizations stay vigilant to address the exponential threats presented by new technologies and to avoid complacency. A strong focus on protecting not just the networks interconnected to our infrastructure but the software applications that operate and support that infrastructure as well as the users accessing those software applications is critical to the safety and security of our nation's energy sector. Through utilization of web application firewalls, multi-factor authentication and identity federation for secure remote access with consistent, policy based access controls and security data analytics on user behavior, the energy sector can continue to evolve its security architecture to address the dissolution of the network perimeter.

I just want to acknowledge the Committee for recognizing the threats to our energy infrastructure and note that collaboration and unity of effort amongst stakeholders will be critical to meeting this challenge. I would also like to recognize the others on this panel who are here working together to address these issues. Thank you to the Committee for convening this hearing on such timely issues. F5 would also be happy to provide any supplemental materials upon request following the hearing.

Senator CANTWELL. Thank you. Thank you.

Mr. Imhoff, thank you so much for being here today. Hopefully we will see you tomorrow as well, but thank you for being here to testify at today's hearing.

STATEMENT OF CARL IMHOFF, MANAGER, GRID RESEARCH PROGRAM, PACIFIC NORTHWEST NATIONAL LABORATORY, U.S. DEPARTMENT OF ENERGY

Mr. IMHOFF. I will be there tomorrow.

Thank you very much, Senator Cantwell, for the opportunity to appear. And thank you, Mr. Secretary, for joining us in the beautiful Pacific Northwest. My mission today is to discuss issues around grid resiliency and emergency response, particularly as they relate to grid modernization.

My name is Carl Imhoff. I lead the Grid Research Program at the Pacific Northwest National Laboratory (PNNL), and I also co-chair the Grid Modernization Laboratory Consortium which is a membership of 13 national laboratories and over 100 industry and academic partners supporting DOE's unified Grid Modernization Initiative.

For more than two decades PNNL has supported power system resilience and innovation for the State of Washington, the Pacific Northwest and the nation. In that time, we lead in the delivery to the nation, a network of 2,000 high speed, synchrophasor monitors that monitor the nation 30 samples a second, 24/7.

We've also delivered innovations in distributed control and demand response with the promise of delivering demand at scale and providing grid services faster, greener, cheaper and supported the nation's largest Smart Grid demonstration in doing so.

We're delivering high performance computing that's taking security tools from days to seconds to converge and helping the operators, such as Bonneville, monitor the system and avoid outages and so we've had a phenomenal long record of support to the grid. And we'll continue to do so going forward.

My assignment was to talk about the link between grid modernization and security and resilience, but before I do I have to frame my two key recommendations for the session. One, important to deliver next generation, real time tools for situational awareness, risk assessment and grid operations that transform our nation's capacity to assess risk in real time and help mitigate outages with assisted support for operators in real time. Secondly, to improve the emergency response capabilities leveraging new data sources and new analytic tools to enhance both regional and local planning but also then preparation for major extreme events.

So let me start with the highlights of why is the grid important? What's changed in the landscape of the grid? And then comment on how can grid modernization enhance our resilience in emergency response?

The future power system is facing substantially more complex conditions and risk going forward. Today we have increased storm frequency and intensity. We see increased interdependencies between grid systems and other critical infrastructure such as natural gas pipelines, communications and emerging market models.

New digital technology is transforming the availability of new consumer services at the grid edge where it also increases the attack planning and increases the cybersecurity challenge. Overall, the grid faces increased complexity in supply, demand and business models, and this is a grid that today is very important to our economy but it's going to be more strategic into the future.

Our current economy is increasingly digital but the consumers are looking for more benefits from IT and intelligent devices and all at the edge. Much of the past climate research is showing that electrification is a key to going in terms of de-carbonization. So the grid is essential today and it will become increasingly more strategic in the future.

So how does a modernized grid support emergency response? Let me frame three options.

First, it will deliver improved grid infrastructure resilience such as new distribution feeders that better resist natural and human threats and recover faster reducing the fundamental need for emergency response. An example is Avista Corp in Spokane which achieved 1.5 million avoided customer outage minutes in 2013 from its Smart Grid Investment Grant effort and advanced metering and distribution automation. They also shortened average outages by ten percent, experienced 21 percent fewer outages and their participation in that partnership with DOE led to an accelerated full system modernization for Vista, accelerated by probably over a decade.

Enhanced real time tools and system visibility will reduce the scope of outages, shorten the time utilities need to identify the outage locations and optimize restoration planning to get the lights back on more quickly. An example is the use of synchophasor monitoring that would have given the Ohio operators, had they had phasor measurement units, an hour and 40-minute warning that Cleveland was pulling away from the rest of the system. The result would have been a much smaller blackout and much faster recovery at much lower cost to the taxpayers.

Upgraded planning tools will better handle the complexity of variable generation and new markets and changing business models, improving emergency response planning, especially for extreme events such as seismic and major regional weather emergencies.

So, how do we achieve these recommendations I offered? Delivering real time tools will help operators better understand risks and options to avoid outages with accuracy far beyond current practice.

One promising opportunity is the delivery of near real time risk contingency analysis that's basically looking at the 40,000 to 60,000 outlets and saying if we lose certain numbers of these what does that do to the security of our grid?

Today operators conduct power flow to identify and rank all system risks. We've accelerated this analysis with advanced computing to take the computation from days to seconds. In the case of the Western interconnection, this method cut the computation run from 26 hours to 7 seconds. This improvement gives operators near real time situational awareness of risks and options to mitigate outages.

Experiments at PNNL's control rooms, that you'll see tomorrow, with grid operators showed a 30 percent improvement in their abil-

ity to diagnose and respond to test cases of outages using these new tools.

And an emergency—emerging advanced and planning tools is DOE's commission tool to assess the risk of extremely rare but large cascading events and outages. We, PNNL, worked with ERCOT, Siemens and EPRI to develop an extreme event tool that transformed the utility's ability to conduct such analyses and better prepares the industry to respond to the new NERC standards in terms of extreme events.

An increasingly important element of improved resilience is grid flexibility. You get flexibility in two big ways.

One is energy storage and also advanced distributed controls that the Secretary mentioned earlier. Widespread deployment of energy storage for multiple grid applications requires significant reduction of life cycle costs of energy storage and a validation of the value for the value propositions and multiple grid applications.

To reduce storage costs while improving life cycle performance PNNL is actively engaged in research and the discovery and development of next generation materials and early PNNL R and D advances have been licensed to several companies including UniEnergy which is located in Washington State and is deploying stationary flow batteries for grid scale applications globally.

Through DOE and Washington State Clean Energy funding we are partnered also with Avista, Snohomish, DUD, Puget Sound Energy, to validate the performance and use cases for field deployed grid storage.

A second source of flexibility is advanced distributed control theory. Transactive control concepts, a blending of traditional controls and economic incentives to engage distributive resources at scale and beyond normal utility boundaries have been demonstrated in the Pacific Northwest Smart Grid Demonstration Project and are being extended in the Clean Energy Transactive Campus Project, a partnership between DOE and the Department of Commerce. This project will help demonstrate the benefit of demand side controls across multiple buildings and campuses that can provide load flexibility to reduce peak demand and manage renewable ramping.

Turning to specific emergency response tools, PNNL supports DOE's Office of Infrastructure Security and Energy Restoration (ISER) by developing technologies to aid emergency response. We're launching an effort to support ISER with automated analysis of digital satellite imagery to quickly assess infrastructure damage. It's at work today in the State of Louisiana.

PNNL is also supporting ISER during national emergencies with real time visualization and communication platforms in partnership with HAMMER, the federal training center you'll see in Richland tomorrow.

Finally, in terms of cybersecurity response, PNNL developed a program that, by the end of next month, will provide cyber support to the utilities that generate 75 percent of the nation's electricity. This is a DOE development concept in terms of cyber risk information sharing. It's now led by NERC and industry. The sensors and concepts came from PNNL and we continue to provide analytics for that very important exercise. The next step in that journey is to

find ways to engage the small and mid-size utilities more effectively.

So in conclusion, a modernized grid should substantially improve emergency response by delivering a more resilient system, providing new planning and real time tools to better identify and mitigate outage risks.

Thank you for the opportunity to provide comments. Thank you for your long leadership in terms of Smart Grid and grid modernization.

And thank you, Mr. Secretary, for delivering the first integrated grid strategy in my 30-year career in the national labs.

[The prepared statement of Mr. Imhoff follows:]

Statement of Carl Imhoff
Manager, Grid Research Program
Pacific Northwest National Laboratory
Before the
United States Senate
Committee on Senate Energy and Natural Resources

August 15, 2016

Good morning. Thank you, Senator Cantwell, and Members of the Committee. I appreciate the opportunity to appear before you today to discuss grid resilience and emergency response.

My name is Carl Imhoff, and I lead the Grid Research Program at the Pacific Northwest National Laboratory (PNNL), a Department of Energy (DOE) national laboratory located in Richland, Washington. I also serve as the Co-Chair of DOE's Grid Modernization Laboratory Consortium, a team of national labs that, along with industry and university partners, supports the Department's Grid Modernization Initiative. The consortium members include PNNL, the National Renewable Energy National Laboratory, Sandia National Laboratories, Oak Ridge National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley National Laboratory, Los Alamos National Laboratory, Idaho National Laboratory, Argonne National Laboratory, the National Energy Technology Laboratory, Savannah River National Laboratory, Lawrence Livermore National Laboratory and the National Accelerator Laboratory at Stanford.

For more than two decades, PNNL has supported power system resilience and innovation for the State of Washington, the Pacific Northwest, and the nation. Over this period, the laboratory has led DOE-industry collaborations in developing and deploying synchrophasor technology to help avoid blackouts, and developed and demonstrated transactive control concepts on the Olympic Peninsula in Washington and for the Pacific Northwest Smart Grid Demonstration project—the largest of its kind—to validate smart grid benefits and new control approaches that engage demand and distributed resources at scale. PNNL also delivered the first applications of high performance computing to deliver contingency analysis for the grid in minutes versus days, as well as the first real-time dynamic state estimation to open the door to the future world of predictive grid tools.

Based upon PNNL's extensive experience and leadership in grid research, today I offer two recommendations to enhance the resilience and reliability of our nation's power grid:

1. Improve and deliver real-time tools for situational awareness, risk assessment, and grid operations that transform our nation's capacity to assess risk and to mitigate outages caused by any hazard.

2. Advance emergency response capabilities to enhance regional and local planning and preparation for large scale disaster recovery (such as possible Cascadia seismic events).

Necessity of New Tools for Grid Resilience

The power system of the future will face substantially different challenges and risks than in the past. Today we have well-documented evidence of increased weather impacts, with both the frequency and magnitude of storms increasing. We also see increased interdependencies between grid systems and other critical infrastructures such as the natural gas pipeline system, communications systems, and emerging market models being developed to support clean distributed energy generation. In addition, increased use of digital technology is transforming the availability of new customer services and choice, while at the same time increasing the cyber security challenge.

A modernized grid that addresses these future grid challenges must enhance emergency preparedness and response in three areas:

1. Improved grid flexibility and resilience that reduces the risk and need for emergency response.

2. Real-time tools and system visibility to reduce the scope of outages, shorten the time utilities need to identify outage locations, and optimize restoration planning to get the lights back on more quickly.

3. Improved planning tools that handle the complexity of variable generation, new markets, and changing business models to improve emergency response planning at the local and regional level, particularly for extreme events such as seismic and weather emergencies.

Recommendations for delivering these modernized grid benefits follow.

Improve and deliver real-time tools for situational awareness and grid protection

Delivering real-time tools to better assess risk and operate the electric system will help operators better understand the risks they face and options to avoid outages with accuracy far beyond current practice. An example is the 2003 Northeast blackout. If the synchrophasor system of today had been in place then, operators would have had just over one-and-a-half hours advanced warning that Cleveland was separating from the Eastern Interconnect. The likely outcome would have been a much smaller blackout and faster recovery. A modernized grid reduces the likelihood for emergency response measures and supports faster recovery should an emergency strike.

Increasing efficacy and accuracy in planning and operating the grid enables utilities to better prepare for emergencies of all kinds, and be more nimble in response, with the goal of reducing the extent and duration of outages. Let me share a few efforts underway in the DOE Grid Modernization Initiative:

1. To better enable system planning and protection, DOE's Office of Electricity Deliverability and Energy Reliability (OE) commissioned the development of a new tool to assess the risk of extremely rare but large cascading outages, which are grid blackouts that start with a single failure but quickly ripple out to drop large portions of a regional system. This tool allows grid operators to better enable system planning and protection. PNNL worked with the Electric Reliability Council of Texas, Siemens and the Electric Power Research Institute (EPRI) to develop an extreme event tool that transformed such analyses, and better prepares the industry to respond to the North American Electric Reliability Corporation (NERC) standards requiring better planning for extreme cascading outages. This tool is an open source resource that is scalable for use of advanced computation, positioning it for broad industry use in the case of extremely large, complex outage scenarios. The end result will be much improved risk assessment and planning, leading presumably to fewer large outages such as the 2003 event in the Northeast.

2. Another opportunity for enhancing emergency response is improving wide-area risk assessment of the power system through contingency analysis. Today, power flow simulations are conducted to identify and rank *all* system risks to enable operators to address *key* system risks. This analysis typically requires one or more days at the interconnection level. With high performance computing platforms, PNNL has accelerated contingency analysis to reduce the computation time from days to seconds. In the case of the Western Interconnection, this method cut the computation run time from 26 hours to 7 seconds. This improvement gives operators near real-time situational awareness of risks and options to mitigate these risks. Experiments in PNNL's control room with grid operators showed a 30 percent improvement in operator diagnosis of test outage scenarios using this new approach.

In addition, grid flexibility is an important new development in managing the grid in real time. This flexibility enables the system to better protect against threats and recover more quickly. One example of providing greater grid flexibility to improve grid reliability, resiliency and renewable integration is the development and full-scale deployment of grid scale energy storage. Key to enabling wide spread deployment of energy storage, for multiple grid applications, is to realize a significant reduction in the lifecycle cost of the energy storage systems and validation of the value proposition for multiple grid applications. To reduce energy storage costs, while improving lifecycle performance, PNNL is actively engaged in research in both the discovery and development of next generation energy storage materials. Early PNNL R&D advances have been licensed to several companies, including UniEnergy Technologies, which is located Washington State and is deploying stationary flow batteries for grid scale applications globally. Through DOE and Washington State Clean Energy Funding, PNNL is partnered with Avista Utilities, Snohomish Public Utility District and Puget Sound Energy to validate performance and use-cases for field deployed energy storage technologies. At the national level, PNNL is partnered with Sandia National Laboratories, Argonne National Laboratory, Lawrence Berkeley National Laboratory, Idaho National Laboratory, Brookhaven

National Laboratory and several universities to advance energy storage technologies.

A second example of enhancing grid flexibility is advanced distributed control theory and concepts that enable distributed energy resource (DER) technologies to be integrated at scale across the grid in a way that assures continued reliability, improved resilience, and lower carbon emissions. Transactive control concepts, a blending of traditional and economic incentives to engage distributed resources, have been demonstrated in the Pacific Northwest Smart Grid Demonstration project, which was co-funded by DOE. These concepts are being extended in the Clean Energy and Transactive Campus project, a partnership with DOE and the Washington State Department of Commerce. Taking place at PNNL, the University of Washington and Washington State University, this project will help demonstrate the benefit of demand-side controls across multiple buildings that can provide load flexibility to reduce peak demand and support ramping of renewable energy resources. Finally, the Grid Modernization Laboratory Consortium portfolio includes research on grid architecture and distributed control to further advance the theory and practice of distributed control for a modern grid. This will support improved flexibility by enabling local resources to provide grid services during times of grid stress, such as coordination of multiple micro grids.

Advance emergency response capabilities

PNNL supports DOE's Office of Infrastructure Security and Energy Restoration (ISER) and other federal agencies in their respective energy emergency response functions through the development of technologies and processes to aid the response and recovery to grid interruptions. PNNL is launching an effort to support ISER with its situational awareness capabilities during national emergencies through the automated analysis of digital satellite imagery to quickly assess infrastructure damage, and is also providing improved platforms for the communication of damage assessments and restoration challenges, through its Electricity Infrastructure Operations Center.

PNNL is assisting the electric industry, through NERC, with the deployment of tools and processes to assess the vulnerabilities in their systems and correct them. In the past year, PNNL helped NERC develop the first-ever Design Basis Threat for the electric industry, which is now being rolled out to industry to guide them in prioritizing threats and improving the protection of critical assets.

Additionally, PNNL has been working with another federal sponsor on a grid restoration framework, based upon the Cascadia Subduction Zone scenario, which details the roles, responsibilities, and requirements of the multitude of government agencies and electrical industry service providers in the Northwest.

And finally, PNNL is working with ISER to provide real-time assessment support and expertise during national emergencies through visualization and communication platforms Through established partnership with the HAMMER Federal Training Center in Richland, Washington,

PNNL technologies are being transitioned to real-life applications through HAMMER's emergency response training of ISER responders.

Grid Cyber Resilience

Cyber security is a critical element of all grid-related efforts. PNNL developed the Cyber Risk Information Sharing Program (CRISP) with DOE and is now supporting NERC in the deployment of the program to utilities nationwide. The CRISP program coordinates information sharing between industry and with federal agencies to ensure rapid dissemination of cyber threats and possible remedies. By the end of September 2016, CRISP is expected to cover the utilities that generate 75 percent of the country's power. PNNL is also directly involved in designing and delivering national cyber response exercises, such as GridEX, to better train stakeholders in handling potential cyber events on the grid.

Conclusion

In conclusion, a modernized grid will substantially enhance our ability to see and operate the nation's power system in real time, enabling grid operators to better avoid outages and reduce the extent and duration of those outages that do occur. Advanced planning tools that handle the complexities of the future grid will also improve the assessment of risk for extreme events, improving emergency response planning and implementation.

With these advanced tools developed and deployed, it is important to directly support emergency response agencies with data, situational awareness and analytic tools to help them better assess risk, plan for response, assessment of damage, and on the ground response efforts.

Thank you for the opportunity to provide the Committee with information on the work PNNL and the Grid Modernization Laboratory Consortium are doing in this important area. I would be happy to answer any questions you may have.

Senator CANTWELL. Well thank you, Mr. Imhoff.

I will note though, we've had several stops on this tour already and in each stop the Secretary has gone out of his way to emphasize how important the Pacific Northwest National Laboratory is to the country.

Secretary MONIZ. No, no, I didn't say that.

[Laughter.]

Senator CANTWELL. And to the region.

I just want to thank him, and thank you for being here as a representative of that.

Secretary MONIZ. He wants a raise.

[Laughter.]

Senator CANTWELL. Well, give him one.

[Laughter.]

Senator CANTWELL. So, Dr. Best, thank you so much. We have saved the best for last.

[Laughter.]

Senator CANTWELL. So thank you——

STATEMENT OF DR. LYNN BEST, CHIEF ENVIRONMENTAL OFFICER, SEATTLE CITY LIGHT

Dr. BEST. Madam Chairwoman and Secretary Moniz, I want to thank you on behalf of Seattle City Light for the opportunity to testify today before the Senate Energy and Natural Resources Committee.

My name is Lynn Best, and I am the Environmental Officer for City Light. Seattle City Light provides reliable, renewable and environmentally responsible power to the residents of Seattle and neighboring communities. City Light has been greenhouse gas neutral since 2005, the first electric utility to achieve this distinction.

My testimony today will focus on electric utility resilience in the face of climate change. I will cover City Lights' recently completed Climate Adaptation Plan, our participation in the Department of Energy's Partnership for Energy Sector Climate Resilience and two actual events that reflect the risks identified in the plan, the Oso mudslide and the Goodell Creek Fire.

While City Light owns no fossil fuel resources and obtains 90 percent of its power from hydroelectric resources it—we are affected by climate change.

In 2013 as part of the resiliency strategy for our utility, City Light committed to researching the impacts of climate change on the utility and developing an adaptation plan including actions to minimize these impacts. City Light's Climate Adaptation Plan evaluates how City Light is at risk from climate change, the vulnerability from our operations and infrastructure to these risks and the potential magnitude of the impacts. It then uses this information to help prioritize potential adaptation strategies.

Seattle City Light is also one of 18 electric utilities in the nation participating in Department of Energy's Partnership for Energy Sector Climate Resiliency. This partnership allows utilities to exchange knowledge and best practices as well as receive recognition for their achievements. This partnership also promotes investment in technologies and practices and policies that will enable resilient and modern energy system. City Light looks forward to our contin-

ued collaboration with DOE and other utilities as we work together in this partnership.

The importance of taking action is illustrated by two recent events.

On March 22, 2014 a 300-acre landslide occurred in Oso, Washington that killed 30 people and destroyed a local community. This happened during a March that was the wettest in history. The slide which occurred to the north of City Light's transmission line from the Skagit Hydro project caused minor damage to one tower and came within feet of causing significant damage to the line. The Oso slide is an example of the impacts that we are concerned about with climate change. As the frequency and intensity of heavy participation increases, these loose sedimentary soils are more likely to slide. If the Oso slide had happened on the south side of the valley our transmission lines would have been destroyed for about a mile, at a minimum and potentially more.

In anticipation of this becoming an increasing risk, City Light has applied twice for Federal Emergency Management Act (FEMA) grants to retrofit six towers in this area to limit the amount of damage that could occur from a similar or smaller slide.

While the proximity of Seattle City Light's transmission line constituted a significant risk to the utility, it also provided the opportunity for us to be of assistance to the community when the main arterial of Washington State, Route 530 between the cities of Darrington and Arlington, was destroyed in the slide. A single lane, gravel access road that was our access road for our transmission line was used as a lifeline to bypass that section and reach the community of Darrington.

The Goodell Creek fire started on August 10, 2015, and spread to the woods near the Skagit Hydroelectric Project a few days later. Seattle City Light operates three dams and power houses at Ross, Diablo and Gorge Reservoirs in this area. These facilities produce 20 percent of the power consumed by our customers.

The fire changed direction suddenly and burned under the lines forcing the utility to shut down transmission lines that carry electricity from the project. Spill gates at all three dams were opened to maintain river flows to protect fish. Within 15 minutes—with 15 minutes of warning City Light needed to replace 20 percent of the power needed to serve our load.

The inability to deliver electricity from the Skagit also cost us $100,000 per day. The company town of Diablo was evacuated quickly and Newhalem reduced to only essential personnel. City Light fire fighters worked to protect our assets, the power houses and residences and other structures. The total cost to utility was estimated at $5.3 million.

Wildland fire risk is one that the utility's climate scientists had identified well before the Goodell Creek fire last August. More and longer lasting fires have been occurring on the West side of the Cascades over the past few years. City Light had already completed fire wise projects to protect buildings, and while the fire worked its way to the projects, it stopped before damaging buildings.

The utility also is applying for mitigation funds from FEMA as part of the repairs following this fire to replace the timber saddles

that were part of the Newhalem Creek plant penstock. In addition, we are training our fire fighters in wildfire fighting.

In addition to the physical threat we had to move our balancing authority to our Boundary project. Unfortunately, Boundary has limited storage. It's a run of the river project. And as a result, there was fear that there would not be enough water available at Boundary and we would have to declare a capacity emergency.

We were able to contact our fellow utilities upstream, and we want to thank Avista and Pend Oreille PUD for providing water to allow us to continue to keep Boundary as our balancing authority. This was an excellent example of utilities providing assistance under emergency situations.

Thank you very much for the opportunity to testify.

[The prepared statement of Dr. Best follows:]

Written Testimony

Hearing of the Senate Committee on Energy and Natural Resources
Subcommittee on Energy

United States Senate

Dr. Lynn Best
Chief Environmental Officer
Seattle City Light

"Field Hearing to conduct oversight of the Department of Energy's functions and capabilities to respond to emergencies, including the impacts to critical energy infrastructure"

August 15, 2016

Seattle City Light appreciates this opportunity to testify before the Senate Energy and Natural Resources Committee relating to the Oversight of the United States Department of Energy's functions and capabilities to respond to emergencies, including the impacts to critical energy infrastructure.

Seattle City Light is the 10th largest public electric utility in the United States. It provides reliable, renewable and environmentally responsible power to 750,000 Seattle area residents. City Light has been greenhouse gas neutral since 2005, the first electric utility in the nation to achieve that distinction.

My testimony today focuses on the Seattle City Light recently completed Climate Change Vulnerability Assessment and Adaptation Plan and participation in the Department of Energy's Partnership for Energy Sector Climate Resilience.

Seattle City Light obtains 90% of its energy from hydroelectric resources. Temperature and precipitation changes can have a dramatic effect on these resources. We also depend on hundreds of miles of transmission lines to bring this power to the City of Seattle. In 2013, as part of its resiliency strategy, Seattle City Light committed to researching the impacts of climate change on the utility and developing an adaptation plan including actions to minimize these impacts. City Light's Climate Change Vulnerability Assessment and Adaptation Plan summarizes the impacts of climate change on the utility and identifies potential actions needed to reduce vulnerability and increase resilience.

The goal of adapting or preparing for a changing climate is to ensure that Seattle City Light can continue to meet its mission to produce and deliver environmentally responsible, safe, low-cost, and reliable power as the climate changes. Electric utilities are facing an uncertain future, and a changing climate is one consideration in designing the utility of the future.

Why plan for climate change now?

To some people, climate change may seem like a far-off risk that will not affect electric utilities in the near-term. It can be tempting to label climate change as a "challenge for future generations," but this is not the case for several reasons:

- **Climate change is happening now, globally and here in the Pacific Northwest**. Temperatures have warmed and the effects of these warmer temperatures on snowpack, heat waves, and extreme weather have been detected globally, nationally, and locally in Washington.

- **These impacts are expected to intensify and new impacts will emerge regardless of reductions in emissions of greenhouse gases that cause global warming.** Mitigation to reduce emissions is critical to reducing the long-term magnitude of climate change impacts. However, some impacts are now inevitable because greenhouse gases that have already been emitted to the atmosphere will remain for decades to centuries.
- **Decisions are being made today that will shape the resources and infrastructure of City Light for decades into the future when the impacts of climate change will be more intense.** Decisions are underway regarding the location and design of facilities such as substations and transmission lines, the conditions for operating hydroelectric projects, and the acquisition of power resources and fish habitat. The effects of these decisions will still be in place for decades, so it is important to consider the increasing risk of climate change impacts throughout the life of these decisions.
- **Being proactive and preparing for climate change now can reduce the costs and consequences for City Light, its customers, and the environment.** It will be easier and more cost-effective to consider the impacts of climate change in the planning and design of new infrastructure and power resources now than it will be to retrofit infrastructure or replace resources once the impacts of climate change intensify.

United State Department of Energy Partnership for Energy Sector Climate Resilience

The City of Seattle is one of 18 electric utilities in the nation participating in the United States Department of Energy (DOE) *Partnership for Energy Sector Climate Resiliency (The Partnership)*. The Partnership Agreement signed by the participating utilities expresses a commitment to increasing resilience to climate change. The utilities in the partnership collectively represent 20 percent of the nation's generating capacity and 25 percent of customers. Seattle City Light submitted it Climate Change Vulnerability Assessment and Adaptation Plan to DOE in February 2016. The next deliverable is a Resilience Strategy which is due to DOE in October 2016.

The Partnership builds upon the lessons learned through previously conducted initiatives identified in the President's Climate Action Plan, and reflects the increasing pressures from climate change and extreme weather events on the electric sector in the United State. These vulnerabilities include:

- Decreasing water availability, reducing available thermoelectric and hydropower generation capacity, impacting oil and gas production and impeding barge transport of crude oil, petroleum products and coal.
- Increasing temperature, which leads to an increase in electricity demand for cooling as well as reduces the efficiency of thermoelectric power generation.
- Increasing sea level rise and heightened intensity and frequency of storms and flooding, potentially damaging or disrupting coastal and offshore oil and gas facilities as well as electric transmission and distribution lines, and threatening inland and coastal thermoelectric facilities.

The Partnership has been critical for establishing engagement between DOE and electric utilities that are committed to development and deployment of effective short- and long-term strategies for enhancing resilience to extreme weather and climate change. This allows utilities pursuing action on climate resilience to exchange knowledge and best practices, as well as receive recognition for their achievements. This Partnership also enhances energy security by establishing an energy system resilient to extreme weather and climate change and promotes investment in technologies, practices, and policies that will enable a resilient and modern energy system.

Seattle City Light looks forward to our continued collaboration with DOE and the other utilities as we work together to provide a more resilient energy sector across the United States.

Overview of City Light's Vulnerability and Risk Assessment

The Vulnerability Assessment evaluates how City Light is at risk from climate change. The Assessment describes eight changes in the climate, and resulting changes in natural hazards and streamflow (sea level rise, warmer temperatures and heat waves, changes in extreme weather patterns, increasing risk of wildfires, increasing risk of landslides and erosion, reduced snowpack and changes in runoff timing, higher peak flows and flood risk, and lower summer streamflows) that could affect five aspects of City Light's operations and infrastructure: **shoreline properties, hydroelectric project operations, electricity demand, transmission and distribution, fish habitat protection and restoration**. (See attached Figure: Climate Change Vulnerability Assessment.)

The Assessment then looks at how vulnerable of these operations and infrastructure are to climate change impacts and the potential magnitude of the impact on reliability, safety, financial costs and environmental responsibility. (See attached Table) This Assessment is then used to identify key risks for City Light and help prioritize adaptation actions.

Adaptation Actions

In the plan, City Light identified potential adaption actions to reduce the impacts of climate change on the utility. Adaption actions are intentional changes in policies and operations, or upgrades to infrastructure designed specifically to reduce vulnerability and increase resilience.

Adaptation Actions fall into four general strategies: (1) enhance adaptive capacity, (2) harden infrastructure, (3) increase resilience, or (4) retreating from exposed locations or resources. Many of these adaptation strategies are being considered or implemented by electric utilities across the nation. Each strategy may be useful depending on the magnitude of the impacts and the criticality of the objectives or infrastructure.

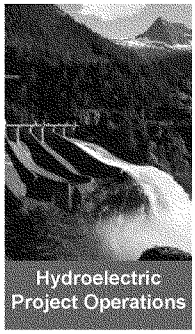
1. **Enhance Adaptive Capacity:** Actions to enhance adaptive capacity increase the ability of the utility to respond to extreme weather and climatic variability or change. Actions taken by electric utilities to increase adaptive capacity include employing meteorologists, investing in weather or wildfire monitoring as well as forecasting systems, and supporting research on the impacts of climate change.
2. **Harden Infrastructure:** Hardening involves protecting infrastructure in place by constructing new reinforced infrastructure or retrofitting existing infrastructure. Examples of hardening include installing submersible saltwater-resistant equipment, elevating infrastructure, or building flood barriers around substations to protect against sea level rise and storm water flooding. In wildfire prone areas, utilities are hardening by converting from wood to steel poles.
3. **Increase Resilience:** Increasing resilience is taking action to enhance the ability of the system to respond or recover from disruptions associated with extreme weather or climate change. Increasing resilience reduces the consequences of impacts in terms of recovery time and cost. Examples of actions by utilities to increase resilience include enhancing vegetation management programs, contracting resources to be readily available for wildfire response, increasing energy efficiency to reduce electricity demand, and diversifying resource portfolios to minimize risk from impacts to any one resource.
4. **Retreat:** Retreating involves relocating a facility from an exposed location. Retreating can also be applied to objectives or power resources. Objectives could be abandoned if they are unlikely to be achievable given climate impacts. Resources could be sold if they are unlikely to provide sufficient benefits in a changing climate. Retreating is potentially the most extreme action and it

is typically considered as a long-term solution, in response to an extreme event, or if other actions are unlikely to sufficiently reduce vulnerability. Retreating can be less politically or socially acceptable, so it may be feasible only in extreme cases. An example of a retreat action by electric utilities is to sell coastal property and move infrastructure out of flood plains in areas with high exposure to sea level rise.

Key Findings: Impacts and Adaptation Actions

Below is a brief description of the impacts on hydroelectric project operations and the transmission and distribution system.

Hydroelectric Project Operations



Seattle City Light's power resources are 90 percent hydropower, 50 percent of which is supplied by five hydroelectric projects owned and operated by the utility. The remaining hydropower is purchased from Bonneville Power Administration's Columbia River hydropower system. In addition to hydropower, City Light operates hydroelectric projects for flood control, instream flows for fish, reservoir recreation, and coordinates the operation of two projects with Seattle Public Utilities for municipal water supply. All these objectives are dependent on snowpack and the seasonal timing of streamflow. The Boundary and Skagit Projects (49 percent of power resources) and the BPA hydropower resources (40 percent) are located in high-elevation, snow-dominated watersheds for which impacts will be slower to emerge but significant by mid-century. The Cedar Falls and South Fork Tolt Projects (1.5 percent) are located in mid-elevation, mixed-rain-and-snow watersheds that will be more exposed to changes in snowpack and streamflow timing in the near-term.

Summary of Impacts

- Less snowpack and earlier snowmelt will affect seasonal operations of hydroelectric projects that are based on historical conditions of water storage in snowpack and snowmelt timing in spring.
- Higher peak flows could increase the frequency of spilling at hydroelectric projects in fall and winter for flood control, which can have financial consequences associated with lost revenue.

  Higher peak flows also challenge operations to protect fish, because more frequent spilling directly causes fish mortality and higher flows scour fish eggs and damage fish habitat downstream of the projects.

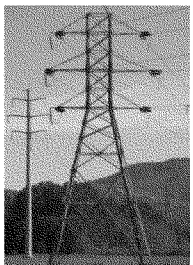
- Lower streamflow in summer will decrease water availability for reservoir recreation, instream flows for fish protection, and hydropower generation, leading to financial consequences for the utility associated with lost revenue from surplus sales and more wholesale purchases to meet summer demand.

Potential Adaptation Actions

- Update and expand the utility's analyses of how operations of the Skagit and Boundary Projects could be adapted to reduce impacts associated with less snowpack, changes in the seasonal timing of streamflow, lower streamflow in summer, and higher peak flows in fall and winter.
- Collaborate with stakeholders to address climate change impacts during relicensing.

- Consider further diversification of Seattle City Light's power resources by increasing non-hydro renewable energy sources that have a seasonal pattern of generation complementary to expected changes in seasonal hydropower generation.

Transmission and Distribution


Transmission and Distribution

Seattle City Light owns and operates a transmission system consisting of over 650 miles of transmission lines and towers connected to the utility's five hydroelectric generation facilities. The utility also owns and operates a distribution system in the Seattle area consisting of 14 distribution substations, 2,337 distribution circuit miles (1,763 overhead and 574 underground circuit miles), and a downtown network system of 220 underground circuit miles. Many miles of transmission lines pass through rural, forested areas in Western Washington with steep, rugged topography. Transmission to and from City Light's distribution system also depends on the western regional transmission system, particularly for transmission from the Boundary hydroelectric project in northeast Washington and wholesale market purchases and sales.

Summary of Impacts

- More frequent tidal flooding and salt water corrosion of distribution equipment could reduce the life expectancy of equipment, increasing costs for maintenance, repair, and replacement.
- Slower outage restoration times due to more intense precipitation and more frequent major storms, particularly when inadequate drainage creates areas of standing water that prevent safe access to repair storm-related outages.
- Increased risk of wildfires causing increase damage to transmission lines and interruptions of transmission and generation at hydroelectric facilities.
- Increased risk of landslides damaging transmission towers and access roads
- Increased risk of river flooding in Western Washington damaging transmission towers, erosion near towers, and damage to access roads.

Potential Adaptation Actions

- Monitor and consider replacing equipment in the transmission and distribution system that is more sensitive to corrosion by salt water in areas that are projected to experience more frequent tidal flooding or will be inundated by sea water within the life expectancy of the equipment.
- Expand the use of the Outage Management System (OMS) to quantify trends in the impacts of extreme weather on outages by specifically documenting additional weather-related causes of outages. This information can be used in cost-benefit analysis of infrastructure upgrades to increase resilience to extreme weather.
- Raise awareness of increasing wildfire risk among staff and increase the capacity of employees to prepare for and respond to this risk through additional wildfire training, upgrading infrastructure with fire-resistant materials, and maintaining defensible space around critical infrastructure.
- Collaborate with adjacent land owners to reduce vegetation fuels and wildfire hazard along the transmission lines and near critical infrastructure at the hydroelectric projects.
- Collaborate with state resource management agencies and academic institutions to map landslide risk along City Light's transmission line rights-of-way.

- Upgrade current transmission infrastructure to be resilient to higher peak flows and flood hazard in locations that currently experience flood-related damage. Consider projected increases in flooding in the design of new transmission projects located in or near historical floodplains.

Case Studies on Climate Impacts

Oso Mud Slide – March 22, 2014

The 300-acre landslide in Oso, Washington, that killed 30 people and destroyed a local community, occurred during a March that was the wettest in history, a condition likely exacerbated by climate change and the geology of the area (soft soils and logging). The slide which occurred to the north of Seattle City Light's transmission line from its Skagit Hydropower Project caused minor damage to one tower and came within feet of causing significant damage to our transmission line (see attached map).

The Oso slide is an example of some of the impacts that we are concerned about with climate change. As the frequency and intensity of heavy precipitation increases, these loose, sedimentary soils are more likely to slide. If the Oso slide had happened on the south side of the valley, our transmission lines would have been destroyed for about a mile at minimum and potentially more. In anticipation of this becoming an increasing risk, City Light has applied twice for a Federal Emergency Management Act grant to retrofit six "dead-end" towers in this area to limit the amount of damage that could occur from a similar, or smaller, slide. We have been unsuccessful to date but look forward to more engagement from federal agencies on the importance of climate resiliency mitigation regarding critical infrastructure.

While the proximity of Seattle City Light's transmission line constituted a significant risk to the utility, it also provided an opportunity for the electric utility to be of major assistance to the community when the main arterial, Washington State Route 530 between the cities of Darrington and Arlington was destroyed in the slide. A single-lane gravel road known as the Seattle City Light Access Road was able to be used to bypass the section of State Route 530 blocked by the landslide. This saved the local community, including emergency vehicles, logging trucks and busses transporting students, hours of commuting and hundreds of additional miles on the odometer



Photo: Oso Mudslide Extent – 2014

until the Route 530 was reconstructed in October.

Goodell Creek Fire – August 2015

Multiple wildfires began on June 28, 2015, in Washington State. For the first time in Washington State history, officials asked residents to volunteer to assist in fighting the wildfires. By early September as many as 3,000 firefighters were deployed against fires that had burned over 900,000 acres of land and President Barack Obama declared the fires a federal emergency.

Photo: A steel tower of Seattle City Light's Skagit transmission line and debris deposited by the landslide near Oso, Washington in March 2014. The debris caused minor damage to a tower.



Photo: Goodell fire near Newhalem, WA, August 2015

The Goodell Creek fire started on August 10, 2015 and spread to the woods near the Skagit Hydroelectric project a few days later. Seattle City Light operates three dams and powerhouses at the Ross, Diablo and Gorge reservoirs in this area. These facilities produce about 20 percent of the power consumed by our customers and are served by transmission lines owned by Seattle City Light. The fire changed direction suddenly and burned under the lines; debris from the fire caused the lines to start arcing, forcing the utility to shut down the transmission lines that carry electricity from the hydroelectric project. Spillgates at all three dams were opened to maintain river flows to protect fish. With 15 minutes of warning, City Light needed to replace 20% of the power needed to serve load. The inability to deliver electricity from the Skagit cost the utility about $100,000 per day. The company town of Diablo was evacuated and Newhalem reduced to only essential personnel. City Light firefighters worked to protect our assets – the powerhouses and residences and other structures in Newhalem. While no structures were lost at Newhalem, a fiber optic cable and several wood poles and the penstock for one small project were destroyed. Total cost to the utility was estimated at $5.3 million.



Wildland fire risk was one the utility's climate scientist had identified well before the Goodell Creek fire last August. More, and longer lasting, fires have been occurring on the west side of the Cascades over the past few years. Seattle City has already

completed "Firewise" projects to protect buildings, and while the fire worked its way to one of the projects, it stopped before damaging the nearby buildings. The utility is also applying for mitigation funds with FEMA as part of the repairs following Goodell Creek to replace the existing heavy timber saddles, or supports, for the Newhalem power plant penstock with concrete saddles. The fire damaged five of the saddles and took the penstock out-of-service over the winter until the replacements could be installed. In addition, City Light plans to train its firefighters in wildfire fighting.

Photo: Goodell fire near Newhalem, WA, August 2015

In addition to the physical threat to the infrastructure at our Skagit Hydropower Project, during the course of the Goodell fire the week of August 17th, 2015 when we had to cease generation operations at Skagit, and de-energize the power houses and main transmission lines, the utility's Balancing Area Authority (BA) requirement had to be moved to the Boundary project, with a single unit partially loaded to allow for regulation (varying generation up or down to match the variations in our customers' loads). Unfortunately, Boundary has only very limited storage as a "run of river" project. As a result of this, the water available at Boundary was limited and we projected we would run out of water at Boundary and be at risk of placing the System Operations Center in a position of having to declare a capacity emergency with Peak Reliability due to the lack of ability to reliably carry reserves on behalf of our BA. However, staff anticipated this and successfully obtained water from parties upstream of Boundary to allow us to re-fill the reservoir and continue to successfully carry needed reserves at Boundary. This is an excellent example of utilities providing assistance to another utility in an emergency situation. Early next week City Light was able to re-energize the Skagit project and move our reserves back over to Skagit and resolve the matter.

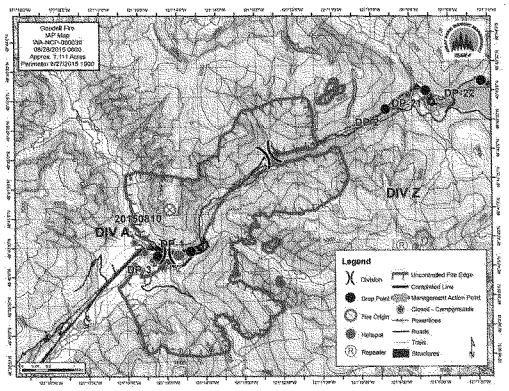


Photo: Goodell Creek Fire Map – 2015

Cyber Security Risk Management

In addition to Climate Adaptation planning, City Light implemented programs to address cyber security and critical infrastructure protection. In partnership with Seattle IT, City Light has instituted processes, training, and controls to protect against cyber threats and maintain reliable operations. Steps taken by City Light include hardening of critical City Light networks and systems; isolating command and control systems from the Internet or hardening security protocols where isolation is not feasible; network surveillance; and controlling access to systems and facilities. City Light is in compliance with the federal cyber security standards mandated by the North American Electric Reliability Corporation, NERC.

Finally, City Light regularly monitors cyber threats and conducts voluntary cyber security assessments with the intent to identify areas for continual improvement. These findings are integrated into a work program that forms the basis of its cyber security program.

Senator CANTWELL. Thank you, Dr. Best.

Again, thanks to all the witnesses today. You obviously represent the interests of our infrastructure across a variety of different areas in your testimony and help illuminate some of the challenges that we have been dealing with here in the Northwest. So thank you for that.

I would like to begin with you, Mr. Ezelle, as it related to some of the things that you have mentioned, in regards to the National Guard. Obviously, you and I have worked together on Oso and on the two major fires that we have had in our state, so we have had a lot of chances to see the operations on the ground.

In talking with you during some of those events and now hearing from Commissioner Bowman, I just want to ask you on this issue of rail response since I used to say Ports-R-Us, but I think we should say Ports-R-Us and Railroads-R-Us. If you have this many, if you are a state of our position and export opportunity, we have become central for pushing product. Obviously crude by rail, is a major shift change in what we have seen. How are you best preparing for the issues as it relates to the population centers across our state?

Mr. EZELLE. Madam Chair, thanks for the opportunity to comment on that.

The Washington State Legislature realized the criticality of this issue and in this biennium they allocated funding for four FTEs to the Washington Military Department and Emergency Management Division. Our specific purpose is to work with the counties and communities along these railroads, both the incoming rail route along the Columbia Gorge, but also, secondarily, the outgoing routes where the empties travel because the empties also have a hazard themselves.

What we are doing is working with the local Emergency Planning Committees to build detailed response plans within the communities, within the counties so if there is an accident of the type that we saw in Mosier that our communities are ready and able to respond.

Senator CANTWELL. Commissioner Bowman, did you want to add something about your experience from Mosier?

Ms. BOWMAN. Absolutely, thank you.

Maybe to put a little bit of my remarks into context, I wasn't at the derailment but I was there within about three minutes of the derailment. And so I saw the first flames go up, and I was one of the first to call 911 in response.

When after the derailment I ran down to the site, I got within about 200 yards of the derailment and the fire which, I think, as you know, Senator Cantwell, was about 300 feet from the local school.

A couple of things that really stood out for me from that experience was, with all due respect to our first responders in those remote rural areas of the state, this is Oregon, but you know, it's right across the river from Bingen, Washington.

With all due respect to the first responders, they're all volunteer fire fighters, they had no experience in dealing with oil fires and that was immediately evident. Obviously, a fire caused by oil is much different in terms of the way you fight it than is a fire caused

by, excuse me, anything else. The first thing that I did was call Burlington Northern, and I wanted to call out the Burlington Northern for providing expert advice in terms of what the response would be.

What I learned from the experience was that we would have foam trailers coming out to the site. Unfortunately, the foam trailers to deal with the fire didn't arrive. It was almost four hours before they arrived. That was probably the other big take away for me.

I immediately called our CEO at the Port of Seattle and our CEO at the Port of Tacoma and our Fire Chief at the Port of Seattle and directed them to provide any and all resources to the fire that needed to be.

I'm proud that the Port of Seattle provided resources to the Port of Portland who was unable to deploy the foam trailers that arrived about four hours after the fire started. You may have heard later that the foam—that the fire was burning so hot at that point that the foam was disintegrating before it could even get to the rail cars.

So, I guess the biggest take away from this is that, as you probably know, Senator Cantwell, it would have been a wildfire of catastrophic proportion had there been any wind that day. It was an absolute miracle that there was no wind. That's what the Columbia Gorge is known for, is wind, and there was no wind that day.

There's no way that anybody could have responded quickly enough. And so, the things that I would ask the Committee and the Federal Government to consider are a few things.

Providing more resources in terms of training emergency responders in these rural communities. As you noted earlier, it's much different than in an urban area. Having foam trailers 30 miles apart is not adequate. They can't get there in time.

I would say that we need better evacuation plans. There was no plan in this community for evacuating. Literally, residents were sitting trying to figure out what to do. I was on the scene for about two hours. When the third car started to ignite I decided it's time to go home and pack and find a way out of town. By then the freeway was shut down. The only way to leave the town was through a rural, gravel road that is 12 miles back into the town of Hood River. Had there been a wildfire that route would have been closed off as well. So if we're going to have crude by rail we need to have better emergency response.

Senator CANTWELL. Thank you.

As a Port of Seattle Commissioner familiar with our waterfront access, I know we have had the mayor on some of our hearings and briefings on this. He has said he would not direct first responders to respond to an incident in the tunnel in Seattle if such an incident happened. How do you look at that same incident happening anywhere in downtown Seattle?

Ms. BOWMAN. Well certainly the Port of Seattle would offer, again, any and all resources. My understanding is that the Seattle Fire Department should be the first responder at that point. But I don't believe, I'm not sure that they've been trained adequately.

Senator CANTWELL. Do you, having witnessed that incident (I don't know exactly where to put it on a scale, but I would say it

is not one of the most significant events that have happened), but can you imagine that not having catastrophic effects if the Mosier incident happened in Seattle? Is there a way that event could have happened without catastrophic effects to us?

Ms. BOWMAN. No.

You know, again, in the case of Mosier, it was only the fact that there was no wind that day. But in the city of Seattle for something like that to happen in a tunnel, but I don't know how you——

Senator CANTWELL. Or anywhere on the waterfront.

Ms. BOWMAN. Or anywhere on the waterfront.

But it is, given my experience in Mosier, it's something that the Port of Seattle is taking a much closer look at how we can better coordinate with the other local agencies because I don't think it's something that we've really adequately planned for in the past.

We haven't—we don't export oil at the Port of Seattle or at the Port of Tacoma so we haven't had those immediate problems, but certainly the trains go through the city, and we want to work with the railroads to make sure that there is adequate response.

Senator CANTWELL. I think it could be greatly impacted by that because, obviously, the rail goes by your facilities. It is something I am glad you are looking at.

On cyber I wanted to focus on Mr. Rogers. Thank you for your testimony. When you are talking about this perimeter issue versus the software attacks which I feel like is never changing. Someone is going to cook up a new tool a week.

Mr. ROGERS. Right.

Senator CANTWELL. So I get what you are saying. Instead of just protecting the perimeter, let's look at the overall structure and infrastructure and ways in.

How do we create a strong defense? What are the steps and tools we should be taking to address this shift? And what would be the three or four things we should focus on?

Mr. ROGERS. Well, it's interesting. I picked up on Mr. Hairston's comments about some of the efforts that they're doing with their facilities. The implementation of their security operation center, for example, using some, I'm sure, using some of the advanced data analytics that are becoming common within the industry now for security purposes to track user behavior, to determine whether or not access controls are properly being utilized, to determine if a user is acting in a way or accessing an application they shouldn't be. I think that user access piece is one really important piece of that.

Secondly, the follow up to that was the use of the security analytics through having a SOC, as we like to call it in the parlance of the industry, the Security Operations Center. To monitor that traffic is becoming increasingly important because you can't just have a static type of barrier to prevent attack. You need to have people monitoring and watching behavior on the network.

I think actually focusing the strengths of your new perimeter around the application itself, wherever it may reside, increasingly it's knotting your own network. It may be in a cloud somewhere, it may be in a hosted environment, or it may reside on an application on a device somewhere. So the ability to protect that application through use of like a web application firewall and examining

the vulnerabilities of the application itself and how you protect against manipulation of those vulnerabilities.

The idea is while the moat still needs to be there for your traditional network and the wall still needs to be there, it's not enough anymore. You really need to focus on a deeper level of security with more analytics and a more proactive approach.

I think in the past one of the things that's been discussed in a risk profile, particularly here in the U.S. with the risk from terrorism, there's been this concept of failure of imagination. If you can imagine the risk, then you should be able to try to find a way to defend against it. Where we run into problems is we lose that imagination about what the next, where the next attack could come from.

Senator CANTWELL. Well it is certainly asymmetric on all fronts.

[Laughter.]

Senator CANTWELL. And certainly when it comes to cyber, it is asymmetric.

I, again, want to thank our National Guard. The fact that we have a concentration of software and the Air Force and National Guard, they have really taken a lead on, and the University of Washington on this issue of creating, step by step, of really cyber hygiene that they believe that people should be following as well as helping to create a workforce that is focused on getting us the best and brightest in this area.

Mr. Imhoff, what do you think about what Mr. Rogers is saying as it relates to approaching this more from a software perspective and what we need to do from the national laboratory to help with that effort?

Mr. IMHOFF. So I agree with him.

[Laughter.]

Mr. IMHOFF. There's still some work to be done on the perimeters. We learned in the Smart Grid Investment Grants that made the small and mid-sized utilities just can make huge progress by learning basic good housekeeping in terms of maintaining your perimeter and doing training, et cetera. But we need to go beyond that. We need to deliver advanced analytics and part related to crisp that focuses on the business side of the systems.

The other attack plan of interest is the control side of the grid. Part of it is design, next generation controls that are inherently resilient and have adaptive response to threats, all hazards, not just cyber, but the control system helps let the system down and keeps it from propagating throughout the control system. That's part of the strategy, the other part of anticipating where we're heading.

We recently helped NERC put in place their first designed basic threat assessment, looking at cyber, which basically says who are the actors? What are their intentions? What tools do they have? What options might they deploy to help attack?

It's really getting into the analytics figuring out where do you most need the analytics? How do you prioritize your defense inside the perimeter, if you will?

And as you said, that game will never end. It will constantly go and go and go. But that scenario where we can create more distance between us and the adversaries in terms of being more strategic and more systematic from the electric industry standpoint in

terms of how do we anticipate and prepare the defense of the analytics.

Senator CANTWELL. I am going to turn it over to the Secretary, but I do want to ask since you are looking at this from our national lab perspective. One of the things that we have discussed here locally is the notion that we need to continue to upgrade, that some of the security, as was said, is in that application and if we can just continue to get people to upgrade there are great securities in that. Now, of course, we are a software state, and we like upgrades.

[Laughter.]

Senator CANTWELL. Well, let's just say we like upgrades when they work.

[Laughter.]

Senator CANTWELL. And work effectively.

Should we be looking at this from a different mindset? I mean, is this a continual game of how fast can we run ahead of the hackers or is there some level that we should be trying to get people to adjust to as it relates to the software side of the equation? That good hygiene is an upgrade once a year or every two years or something of that nature because we are fixing so many of the identifiable problems.

So any thoughts, Mr. Imhoff or Mr. Rogers, on that?

Mr. IMHOFF. That's a tough question.

I think that the intent in the Grid Modernization Initiative is to build very strong relationships with the vendor community and try to embed best practice and more resilience to the point that Scot mentioned in the next generations of grid vendor tools that are deployed out to the systems. I think there's a lot of room for improvement in ensuring enhanced resilience in those software systems that get deployed out into the future.

One big challenge we have is in the old days most of the grid upgrades were physical assets and going into the future they're going to be digital assets, very different lifetimes and the need for more frequent upgrade and transition, et cetera. So, that's going to be a really different world that we face going forward.

One last comment I would offer is that to unleash the innovation in this space we need to have access to data. We need to preserve the privacy in that data. We need to preserve the security issues around that data.

The Department, through ARPA–E, has been investing in several new grid programs looking at establishing data repositories that are anomalized such that basically you remove the privacy issues in the data but you maintain the physics that make that data useful for looking at innovations. I think this notion of data repositories that are safe and secure, that are available to the innovation community, is a big step forward to help us unleash the innovation but do it in a way that protects privacy and give them data sets that are safe.

I think then, we can raise the bar in terms of the quality of these software upgrades, that the experience of the software engineers and control engineers market the utilities, et cetera and you'll see that tomorrow.

Senator CANTWELL. Before Mr. Rogers replies, I know the subject can seem very dry or very geeky in some ways, but I guarantee you, it's not.

When our own data base in the Congress was hacked, the personnel system and the security clearance of every employee that had a security clearance was violated. You were putting the United States security at great risk, and this is going to continue, to say nothing of the personal side of each employee whose personal data and information was put at risk. We, as a nation, were undermined by those security clearances that were given to each of those individuals.

That is something a foreign agent can act on or take advantage of so getting this right is very important. While I wish the Federal Government was an early adopter, let's just say, Mr. Secretary, they are not an early adopter. We are, kind of, a late adopter when it comes to technology. So I think we are a good example, if you will, in that regard of what is happening with a large sector of our society being very late to moving forward on the latest and greatest.

So Mr. Rogers, my original question, how should we look at this? Is there a new timeframe we should be looking at to stay ahead of people just in the sense of good hygiene?

Mr. ROGERS. I think that brings up a couple of points.

I think there are some opportunities for good hygiene. And I think, as Mr. Imhoff noted earlier, that just through their studies they found some low hanging fruit that some of the smaller producers and infrastructure providers could do to really help the resiliency.

I think that one of the challenges that everybody faces is we have this innovation. We have these growing technologies, and it's the people to operate them.

I think one of the areas, to the point of doing the upgrades, managing the infrastructure, managing the security operation centers and so forth, talent development is going to be critical as well. I think I know that there's some efforts that have been going on that have been mentioned earlier that were very important to get the talent within the area to help run these systems.

I know that, for example, an initiative that F5 did, is we've reached out and have been pairing with the military for training on our products for military veterans as they leave the service.

I think it's these kinds of joint public/private types of efforts that can really go a long ways toward, you know, developing the talent pool because you can have all the software in the systems in the world, but if you don't have the people to operate them or the people that work in the security operations centers to monitor them, then you're really behind the game.

Secretary MONIZ. Can I comment there?

Senator CANTWELL. Yes, so I will turn it over to you, Mr. Secretary.

Secretary MONIZ. Oh, okay.

Senator CANTWELL. You can have as much time as you would like.

Secretary MONIZ. Alright.

Senator CANTWELL. To ask any of the witnesses questions.

Secretary MONIZ. Okay, well first I want to comment on these last two comments a little bit in terms of your question about what steps need to be taken. Actually, Mr. Rogers mentioned earlier in the Ukraine context multifactor authentication is a nominally, straightforward, not always to implement approach that can help a lot in these situations.

Also, Mr. Imhoff's comment, I just wanted to make a comment that goes, it's much more broad than this issue. It's a common issue. It applies here. And that is as we get more and more into a world where large scale computation, big data analytics, machine learning all become part of doing business here the data access is over and over again a big problem. It applies as much to cancer as it does to cybersecurity.

So I think this question of data access is something that the Congress may need to, kind of, deal with in a very broad sense.

Senator CANTWELL. You mean in the repository suggestion that Mr.——

Secretary MONIZ. Well, yeah, I mean from the cancer issue, it's the same thing. There's a lot of data out there but it's hard to get it, proprietary, all kinds of issues how it's heterogeneous in editions. So it's a big problem, a broad problem, and certainly applies here as well.

Well, if I have the floor?

Senator CANTWELL. Yes, go right ahead.

Secretary MONIZ. First of all, terrific panel and actually I have questions for everybody but I will not indulge myself in that. So maybe quick questions and quick answers. Maybe I'll just get three questions out.

First, Mr. Ezelle, Cascadia Rising, you're Washington National Guard, dot, dot, dot. What's the first thing you think you're going to do if it actually happens?

[Laughter.]

Secretary MONIZ. Number two, let me just ask the three questions, then go back.

Mr. Hairston, maybe I should know this given Bonneville's relationship to the Department, but what would be your assessment from Bonneville about the security and ability to respond to a problem with large power transformers, particularly I don't mean just one goes out, but let's say a coordinated action taken against them?

And third for Dr. Best, in your adaptation plan I believe one of the actions put in there is so-called retreating.

Dr. BEST. Yes.

Secretary MONIZ. Taking facilities away from at risk places. How big a challenge is that? I mean, are you talking about relocating everything or just very small number of keynotes.

So those are my three questions.

Mr. EZELLE. Well Mr. Secretary, I'll take a stab at the first one.

I mentioned that probably the key thing that we took away from Cascadia Rising, at least in the emergency management division, was perspective. And it really, truly turned how we look at a catastrophic event on its head.

And in terms of the first thing that we're going to do, obviously, for those of us who are in state government, I think the locals, the first thing is going to be to, essentially, take care of ourselves and

our families. So, do I have to dig out of my house, has it collapsed on me, will I be able to get to work to function?

And so, that really drove home to us the fact that we need to have extremely detailed response plans. So for every emergency support function whether it's transportation, whether it's communications, whether it's power, all integrated because, you know, what happens in transportation is going to affect what happens in ESF12. It's going to affect what happens in ESF6 and 8.

And so all of our detailed planning needs to be to an extreme level of granularity but then the big take away that we have is that those plans need to be run by somebody else because a significant number of us, who are, we are, who the state may be planning on responding are going to be victors.

And so, it's a case of really, truly putting together that planning, have somebody else outside of our area to be able to run those initial few days of the response until those of us who are in the area can dig out and then start establishing our capability and then starting to take it back.

Hopefully that answers your question.

Secretary MONIZ. Yeah, interesting, yeah. I figure just chaos basically.

Mr. HAIRSTON. Alright, Mr. Secretary, in terms of the second question in respect to our ability to address an attack on a number of substations and subsequently the impact on transformers, it's interesting.

I think we're growing in our ability to be able to respond. I think you might be aware the industry has done a lot of coordination on looking at spare transformer parts, what we can do to, maybe, leverage the number or the amount of inventory that's existing.

But, you know, being able to respond or replace transformers is a difficult measure. It takes months, if not years sometimes, to get the replacement transformers. So that's why it is important for the industry to work together.

The other thing is that and these are so expensive you're not going to make that type of capital investment and have those types of, you know, that type of inventory sitting on the bench, so to speak. So, you know, we've got what is called a Spare Transformer Equipment Program that's industry-wide, that would get a lot more involvement, and I think, positions us to be able to respond.

I know there's been some thought of a, I want to say, the strategic transformer reserve program that's been, again, part of the FAST Act, that contemplates being able to respond in terms of a disruptive event. I think that would be a good complement to the existing program. So that's something that I think is worth definitely exploring for the industry.

Secretary MONIZ. Good. We'll have a report on that. You're probably working on it. Some people from BPA at least are working on it for Congress this year.

Mr. HAIRSTON. Yes.

Dr. BEST. Okay, retreating.

So, I want to point out that retreating was the fourth of four different strategies that we put forward. We also said it was a strategy, sort of, of last resort because of the consequences of it.

Mostly what we've looked at——

Secretary MONIZ. That's why I asked about it.

Dr. BEST. Yeah, yeah.

So we've looked at hardening of infrastructure like we are looking at the Oso-type landslide situation. We're looking at increasing resilience, like fire wise, for our facilities.

But we looked at retreating where you have a facility that is in, say, a flood plain that you know is going to be repeatedly at risk. And luckily for Seattle right now it doesn't look as if Seattle City Light has critical infrastructure in the areas that are going to be flooded in the city. And so, we're looking at the, what I would say, lesser infrastructure in those areas.

But I think also this is a reason why it's so important to work on climate preparation now because the decisions utilities are making now will last for 20, 30, 40, sometimes 50 years. And if we do the, make the right decisions now we can greatly reduce the impacts on our customers, on the utility and also on the environment.

And so, I would say that one of the reasons for highlighting that in the plan is to say we really don't want to be put in the position of having to move massive infrastructure or desert it and recreate it somewhere else.

So I think that's one of the reasons that to be aware that you can't harden everything necessarily and you want to be careful about where you put things.

Senator CANTWELL. Well, I would just add to that, Dr. Best.

I know we are going to wrap up here but if your other utility associates were here today they would be singing the same song as it relates to our wildfires and the amount of transmission that burned up and the costs that are now left with utilities to try to replace that in many parts of our state. Millions of dollars of infrastructure in an afternoon just gone. So figuring this out is really, really important for us.

I just want to thank the panelists and again, the Secretary, for your testimony. You have given us some good ideas to think about.

As a summation point from my side I definitely am hearing and sensing both from you, Mr. Secretary, but also from our witnesses, that we are both making preparatory plans and we are both thinking of these challenges but we need to somehow marry them together. The state and local and fed need to figure out how we continue to have this discussion and marry our solutions so we can give the American people our best efforts on these challenging new energy problems.

I just thank everybody for being here today to give us that insight, and again, you, for traveling to the Northwest.

Again, this subject is probably something we would like to put off to another day, but the realities of it are that they are affecting us right now. So I thank you for your willingness to come here and do that.

I don't know if you have any concluding remarks you would like to make?

Secretary MONIZ. No, just to thank you for the hearing and thank the witnesses because there's some very interesting information there. We'll follow up.

Senator CANTWELL. Great.

Thank you all very much.

Secretary MONIZ. Thank you.
Senator CANTWELL. We are adjourned.
[Whereupon, at 1:39 p.m. the hearing was adjourned.]

APPENDIX MATERIAL SUBMITTED

BNSF Railway Response
Senate Energy & Natural Resources Committee
Field Hearing to Conduct Oversight of the U.S. Department of Energy's Functions and Capabilities to Respond to Energy-Related Emergencies, Including Impacts to Critical Energy Infrastructure
Monday, August 15, 2016

BNSF provided the attached letter to the Senate Energy Committee and to Secretary Moniz from BNSF Chairman Matthew Rose prior to the August 15 field hearing to Conduct Oversight of the U.S. Department of Energy's Functions and Capabilities to Respond to Energy-Related Emergencies, Including Impacts to Critical Energy Infrastructure. This letter was an update on BNSF's safety record, specifically the measures it has taken toward the safety of crude-by-rail, and its significant investment in capacity expansion.

BNSF seeks to clarify the record created at the hearing regarding freight rail. First, the record did not recognize the railroad industry's safety record and the significant steps taken to enhance the safety of crude-by-rail by railroads on their own and also as facilitated by the U.S. Department of Transportation and Congress. Second, the hearing record did not acknowledge the significant investments that have been made by the freight rail industry. Specifically, it was asserted at the hearing that crude-by-rail is moving at the expense of other traffic on the rail network, and that other commodities were being "pushed off" because capacity is constrained. The seriousness with which BNSF takes safety, and its historic level of investment to ensure best-ever service, particularly on Washington's "Great Northern" line, prompts this statement to correct the inaccurate impression as reflected in the record of the hearing.

BNSF Network

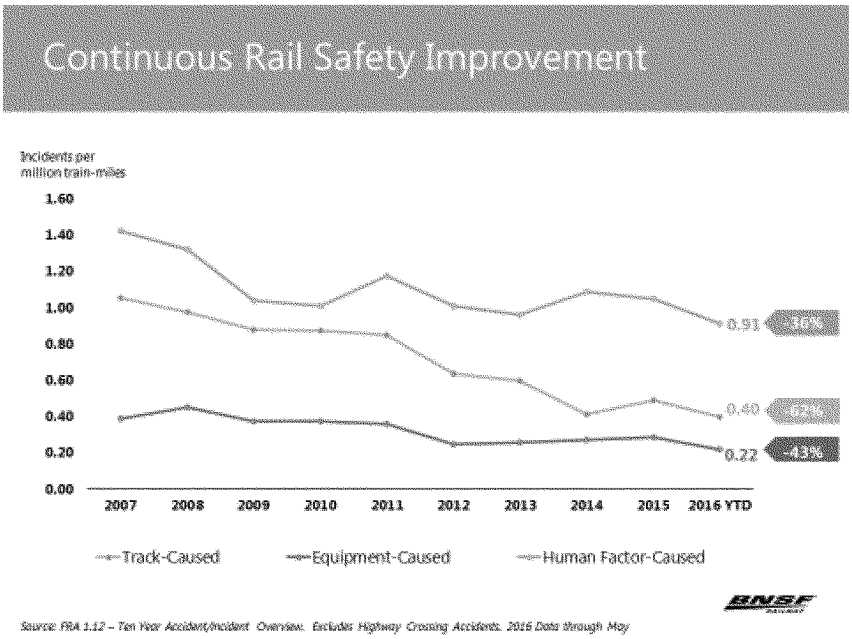
BNSF operates one of the largest freight rail systems in North America with approximately 32,500 route miles in 28 states and also operates in three Canadian Provinces. BNSF has approximately 42,000 employees and operates about 1,200 trains per day. Total volume for all types of freight hauled by BNSF last year was 10.3 million units, the most of any railroad.

BNSF employs approximately 4,000 people in Washington with an annual payroll of more than $309 million, and operates major rail yards in Auburn, Bellingham, Centralia, Everett, Pasco, Seattle, Spokane, Tacoma, Vancouver, Wenatchee, Wishram and Yakima. We also operate shops in Seattle, Spokane and Vancouver, two intermodal facilities in Seattle and one in Spokane. BNSF currently owns and operates more than 1,300 miles of track in Washington, moving more than 1.5 million carloads of freight through the state on annual basis.

Safety

BNSF and the rail industry are currently experiencing the safest years on record, showing significant improvement over the past decade. Over the last 10 years BNSF has seen a reduction of nearly 50 percent in mainline derailments, which is consistently better than the rail industry average.

Continued robust investment in infrastructure has played a direct role in this success, along with the deployment of technology and safe operating practices, which involve rules compliance and a commitment to safety by BNSF's employees. Safety is the foundation of our business, so it is the most important thing we do.



Technology has played a significant role in this success. As BNSF testified before the Senate Commerce Committee in 2015, BNSF employs numerous technologies on the railroad to reduce risk and drive continuous safety improvement. Below are examples of the spectrum of technologies being deployed on the network. Combined, they produce a body of data which BNSF mines through big data analytics tools, created in partnership with IBM, to detect conditions which could produce an incident, and ultimately predict and prevent them. These technologies include:

- Track geometry vehicles that utilize sophisticated electronic and optical measuring devices to monitor all aspects of track infrastructure
- Rail defect detection systems that utilize ultrasonic technology to detect internal rail defects
- Wheel temperature detectors, using infrared technology, to identify wheel bearing fatigue
- Machine Visioning systems to inspect freight cars in passing trains for defects

- Unmanned Aircraft Systems (UAS)—drones—for supplemental visual track & bridge inspections in a variety of conditions. BNSF is one of three companies awarded Pathfinder Program status by the FAA for extended track integrity flights.

Positive Train Control (PTC) is another significant safety technology being deployed across the BNSF network. BNSF expects to be in compliance with the deadline established by Congress in the Surface Transportation Extension Act of 2015.

In addition to rail technology and investment in rail infrastructure, BNSF also focuses on the development of a Safety Culture of Commitment by all BNSF employees which is a critical element of the company's approach to overall risk reduction.

Crude-by-rail safety has been an important focus of the private sector (railroads and shippers) and public policy makers. An oversight exercise of critical energy infrastructure should be informed by these significant efforts. Attached is an overview of these actions. In summary, one of the most significant points is that BNSF has been able to work with its customers to get the newest, safest tank cars on the railroad as quickly as possible. As of August 2016, BNSF has eliminated its use of legacy DOT-111 cars for crude transport in unit trains, a direct result of this collaborative effort.

Another significant point is the extent to which BNSF continues to work with first responders and communities on emergency preparedness. In Washington alone, BNSF has held approximately 95 emergency response training sessions since 2014 and sponsored more than 250 first responders to attend a three day crude oil training at the Transportation Technology Center, Inc. (TTCI) and at Texas A&M. In addition, BNSF has more than 30 responders in Washington and a number of fire and spill trailers, both in-house and through contractors, in the Pacific Northwest.

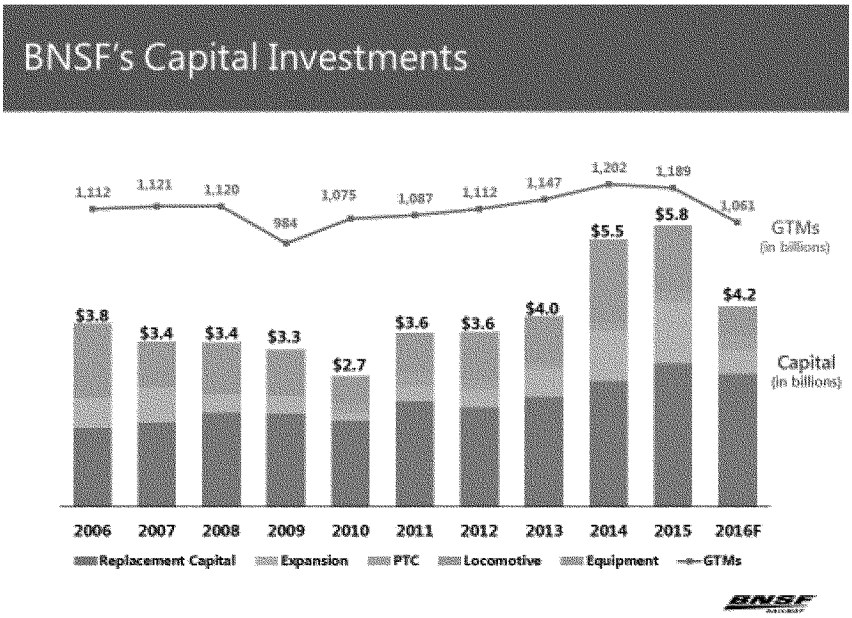
Investment and Rail Service

The situation in which we find our service now is completely different than that of two years ago, which was not recognized at the hearing. Shippers in Washington, and across the BNSF network, are experiencing best-ever service. This is confirmed in Surface Transportation Board service filings and, more importantly, by customers themselves.

Over the last three years alone, BNSF capital investment has reached historic levels, particularly on Washington's "Great Northern" line. Over that time, BNSF has invested more than $550 million in Washington and $3.5 billion in our rail lines connecting the Midwest to the Northwest. Since 2000, BNSF has invested $53 billion in capital across its network, and $15.3 billion over the last three years.

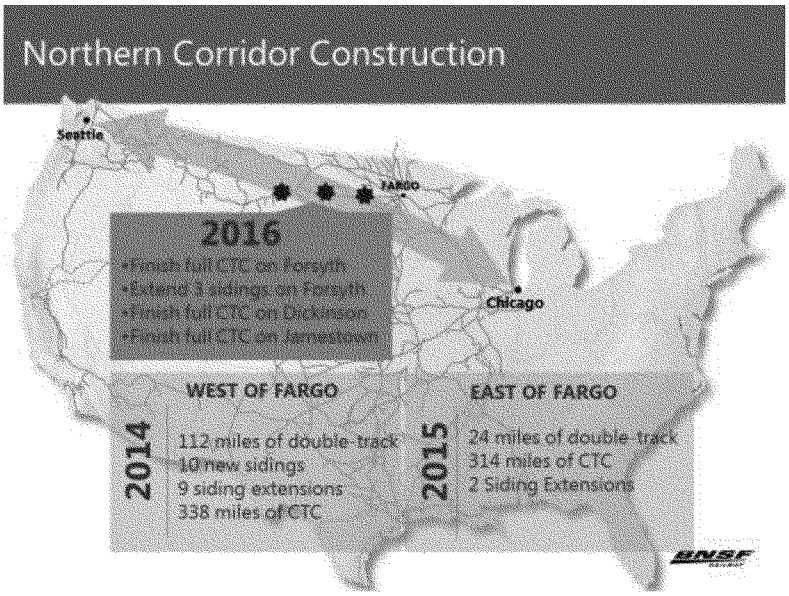
These recent investments allowed BNSF to add about 1,000 miles of Centralized Traffic Control (CTC), 16 sidings and extended 24 sidings. Over 200 miles of double-track will be added to the network. Essentially, the Great Northern Corridor has been transformed to the functional capacity equivalent of the Los Angeles to Chicago Transcon Corridor, the busiest route on the BNSF network. The Great Northern Corridor now has two main lines on nearly 50 percent of the route between the Pacific Northwest and Chicago.

In 2016, BNSF plans to spend $4.2 billion on capital projects across its network to support maintenance and expansion. This includes $2.8 billion for network maintenance, $300 million for continued implementation of positive train control, and $600 million for locomotives, freight cars and other equipment acquisitions. This includes the acquisition of 150 locomotives under a minimum purchase agreement with the manufacturer. In addition, we plan to invest $500 million on various capacity expansion projects, primarily a continuation of projects that were started in 2015.

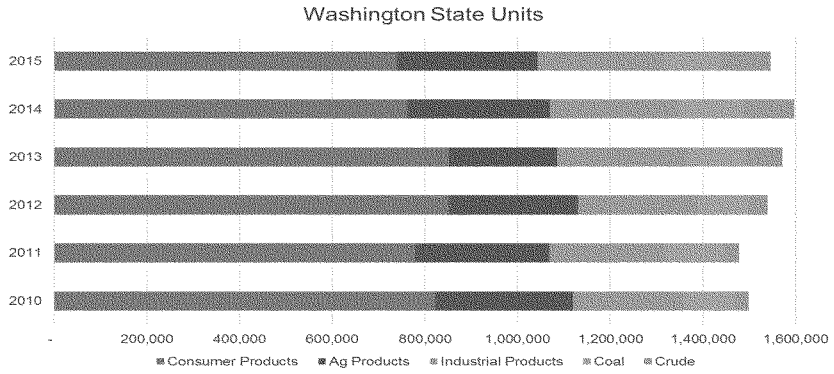


These investments increase the competitiveness of all BNSF customers and there is ample capacity to move all of BNSF's current business as well as significant growth in the future in any segment of BNSF business. For Washington State, this means more capacity for Washington shippers—grain, Boeing fuselages, and Washington lumber products to name a few—and Washington ports. We have already moved record levels of soybeans to Northwest ports through July.

It was asserted at the hearing that crude-by-rail and coal are moving at the expense of other traffic on the network. This has never been the case, despite the importance of crude movements to the Pacific Northwest region.



While the percentages of crude oil shipments moving on the BNSF increased significantly from 525 crude oil loads in 2010 to 53,000 in 2015, this was simply a reflection of the fact that prior to 2010, BNSF and the rail industry handled very little crude. However, to put this more into the proper context, movements of crude on the BNSF network represented merely five percent of total rail traffic at its height in 2014. Citing 10,000 percent increases in crude is, therefore, misleading in terms of its potential impact to the rail network. This can also be seen in comparison to total Washington freight traffic below.



According to the U.S Energy Information Administration, Washington is a principal refining center serving Pacific Northwest markets. This refining provides gas for our cars, jet fuel for airplanes, and fuel for the maritime and industrial sectors of the state. In fact, Washington is among the top 10 states in the nation in jet fuel consumption. Bringing crude-by-rail from North Dakota is the most economical way for Washington refineries to fulfill this demand. In other words, BNSF is moving this commodity because Washington's economy requires it and using U.S. product keeps fuel prices lower than bringing crude into the Puget Sound by super tankers from places like the Middle East and Nigeria. Consumers ultimately benefit at the pump.

BNSF's network velocity is tracked through filings at the Surface Transportation Board and information is also made available by the Association of American Railroads (AAR). All sectors of business are experiencing excellent service. Specifically, agriculture shuttle turns per month to the Pacific Northwest have recovered from a low of 1.9 in December 2013 and are running at almost 3.0. We communicate frequently with our customers and have not heard concern about our performance. If there is a customer that believes we are not providing service that meets their expectations, we would like to hear from them.

BNSF's network is an important part of the $28.5 billion rail-related economic activity in the state, much of it trade-related—the backbone of the region's economy. The statements at the hearing would give the impression that Washington's economy is currently plagued with unsafe freight movements of a product no one wants, resulting in serious congestion for all other commodities. This is false rhetoric, and does not serve the Northwest's reputation as a competitive center for international trade. BNSF welcomes a discussion on the safety and capabilities of a supply chain that allows the U.S. and Washington goods to be competitive in markets across the globe. However, characterizations of freight rail should be fair, and BNSF will make every effort to ensure that the public, policy makers and its customers have accurate information.



MATTHEW K. ROSE
Executive Chairman

BNSF Railway Company
P.O. Box 961052
Fort Worth, TX 76161-0052
2650 Lou Menk Drive
Fort Worth, TX 76131-2830
817.867.6100
817.352.7430 Fax

August 12, 2016

The Honorable Maria Cantwell
United States Senate
Washington, DC 20510

Dear Senator Cantwell:

I write to provide you with information that I hope will be helpful as you engage in a public dialogue about freight rail at the Senate Energy Committee hearing, and elsewhere.

BNSF Railway's significant investment over the last several years, particularly on our Northern Tier and specifically in Washington, has expanded network capacity and fluidity. BNSF is providing best-ever service to all its customers. In April 2015, you cited the Department of Energy Quadrennial Energy Review's (QER) assertion that service disruptions were causing delays in agriculture shipments. That finding was obsolete before the QER was even printed, and BNSF moved record levels of agricultural products in 2015. As you and I have discussed, the end of 2013 and 2014 was a difficult period for BNSF service as volumes across commodities spiked. BNSF struggled to carry peak levels of freight and worked to maintain the integrity of its network operations for all customers.

The situation in which we find ourselves now could not be more different. After three years of unprecedented levels of network investment, much of it directed to the lines that connect Washington to the Mid-West, BNSF's customers are experiencing the benefit of expanded capacity. BNSF has invested more than $3.5 billion in the northern lines over the last three years alone. These investments are an important part of our ability to move record agriculture exports to Pacific Northwest (PNW) ports again this year, and our efforts to attract domestic intermodal business to the Puget Sound market to take trucks off the highways in partnership with our trucking customers. Significantly, this investment is critical to PNW ports, with whom we partner to attract export and import freight business. Our commitment to operating a safe, efficient and reliable network helps Washington remain the path for world trade, and it is an important part of the $28.5 billion rail-related economic activity in the state.

I also want to provide you with an update on rail safety. BNSF's safety record improves each year thanks to our investments, but also because of the utilization of technology that allows us to continually reduce risk in every category of safety. This is true of crude-by-rail movements, as well. BNSF regularly exceeds federal standards in pursuit of risk reduction consistent with real-time network operations. Most crude oil routes on BNSF are inspected up to four times per week, more than twice the inspection frequency required by the Federal Railroad

Administration (FRA), and our busiest main lines can be inspected daily, which includes our route through the Columbia River Gorge along the Washington side.

BNSF has testified before you and the Senate Commerce Committee regarding its use of big data analytics to improve safety outcomes related to equipment, locomotives and track. BNSF utilizes a myriad of detection technologies along key routes on our network which send thousands of messages daily as they monitor for early signs of potential problems that could cause premature wear or failure. (Detectors are placed even more closely together in places like the Gorge to ensure potential issues are elevated as quickly as possible.) BNSF believes that this technology and the related analytics provide the means to take our very good safety record to the next level of targeted risk reduction.

Our commitment to safety includes enhanced coordination with Washington's first responder and safety community. Last year, BNSF trained upward of 10,000 public emergency responders, with nearly 900 of these responders from Washington, on how to safely respond to hazmat incidents. Also, in the last three years, BNSF has sponsored more than 250 Washington first responders at a three-day specialized crude-by-rail training in Colorado and at Texas A&M.

BNSF has specialized equipment and hazmat responders staged across its network to deal with hazmat and crude oil incidents, including firefighting and spill cleanup. During a hazardous materials incident, BNSF responders will be responding in unison with public responders, based on planning for combined efforts to achieve the most effective incident response. In Washington, BNSF has resources and equipment staged in Everett, Seattle, Vancouver, Longview, Bingen, Wishram, Pasco and Spokane and has 32 Hazmat Technician Level Responders located in Everett, Pasco, Seattle, Spokane, Vancouver and Wenatchee.

New, advanced technologies are also improving coordination between BNSF and response agencies. Two new technologies – AskRail and SECURETRAK – provide immediate access to real-time data about individual rail cars, cargoes, and location information for first responders. The AskRail mobile app, developed by the rail industry, provides first responders with car-specific data for hazmat contents and railroad contacts during an incident. BNSF's SECURETRAK, which is a real-time, web-based Geographic Information System tracking program, is available to state and/or regional emergency centers.

I am attaching several PowerPoint slides that illustrate the points made above. I appreciate the opportunity to update you on BNSF's operations in Washington and, as always, am available for continued discussion.

Sincerely,

Matthew K. Rose

cc: The Honorable Lisa Murkowski
The Honorable Ernest Moniz

Attachment 2
Crude-by-Rail Actions

Congressional and Executive Actions

2013

August 2013: Federal Railroad Administration (FRA) Emergency Order No. 28
- Establishing Additional Requirements for Attendance and Securement of Certain Freight Trains and Vehicles on Mainline Track or Mainline Siding Outside of a Yard or Terminal (https://www.fra.dot.gov/eLib/details/L04719)

August 2013: FRA Safety Advisory No. 2013-06
- Preventing Unintended Movement of Freight Trains and Vehicles on Mainline Track or Mainline Siding Outside of a Yard or Terminal http://www.fra.dot.gov/eLib/details/L04720

September 2013: Pipeline and Hazardous Materials Safety Administration (PHMSA) publishes Advance Notice of Proposed Rulemaking seeking public comment on a proposed rule requiring comprehensive improvements to rail safety of flammable liquids. (https://www.federalregister.gov/articles/2013/09/06/2013-21621/hazardous-materials-rail-petitions-and-recommendations-to-improve-the-safety-of-railroad-tank-car)

November 2013: PHMSA-FRA Safety Advisory No. 2013-07
- Safety and Security Plans for Class 3 Hazardous Materials Transported by Rail (https://www.fra.dot.gov/eLib/details/L04861#p3_z5_gD_lSO_lSD_lSA_krail)

2014

February 2014: U.S. DOT Emergency Order No. DOT- OST-2014-0025
- Requires stricter standards to transport crude oil by rail including increased internal rail inspections (at least one additional above FRA requirements) and at least two geometry car inspections each year on crude oil routes
- (https://www.transportation.gov/sites/dot.gov/files/docs/Emergency%20Restriction%20-%20Prohibition%20Order%20(Docket%20DOT-OST-2014-0025).pdf)

February 2014: U.S. DOT-Rail Industry Voluntary Agreement
- Additional special handling for key trains include:
  - Lower Speeds: Municipal speed restriction of 40 mph for Key Trains carrying crude oil in DOT-111 through High Threat Urban Areas (HTUAs)
  - Increased Trackside Safety Technology: Additional Hot Bearing Detectors (HBD) on crude oil routes (max 40 mile spacing)
  - Risk-Based Traffic Routing Technology: Use of Rail Corridor Risk Management System (RCRMS) to determine the most safe and secure routes for crude trains of 20 or more loaded cars
  - Increased rail detection frequencies on Key Train routes
  - Rail Industry committed $5M to develop and deliver crude-specific training to First Responders at Transportation Technology Center Inc.

  - Rail Industry commits to develop an inventory of emergency response resources
- (https://www.transportation.gov/briefing-room/letter-association-american-railroads)

May 2014: FRA Safety Advisory No. 2014-01

- Recommendations for Tanks Cars Used for the Transportation of Petroleum Crude Oil by Rail urging shippers and carriers to avoid the use of DOT-111 for Bakken "to the extent possible."
(https://www.fra.dot.gov/eLib/details/L05222#p1_z5_gD_lSO_lSD_lSA_kcrude)

May 2014: U.S. DOT Emergency Order No. DOT-OST-2014-0067

- Required each railroad to notify and provide to each State Emergency Response Commission (SERC) a reasonable estimate of the number of crude oil trains per week that move through each county.
(https://www.fra.dot.gov/eLib/details/L05225#p1_z5_gD_lSO_lSD_lSA_kcrude)

July 2014: U.S. DOT releases comprehensive rulemaking proposal to improve the safe transportation of large quantities of flammable materials by rail, including a Notice of Proposed Rulemaking for enhanced tank car standards, an Advanced Notice of Proposed Rulemaking seeking to expand oil spill response planning requirements for shipments of flammable materials, and a report summarizing the analysis of Bakken crude oil data gathered by PHMSA and FRA.

2015

April 2015: FRA Emergency Order No. 30

- Establishing a Maximum Operating Speed of 40 mph in High-Threat Urban Areas for Certain Trains Transporting Large Quantities of Class 3 Flammable Liquids. *(BNSF current operating practices already exceeded this EO)*
(https://www.fra.dot.gov/eLib/details/L16319#p1_z5_gD_lSO_lSD_lSA_kcrude)

April 2015: FRA Safety Advisory No. 2015-01

- Mechanical Inspections and Wheel Impact Load Detector Standards for Trains Transporting Large Amounts of Class 3 Flammable Liquids
(https://www.fra.dot.gov/eLib/details/L16322#p1_z5_gD_lSO_lSD_lSA_kcrude)

April 2015: FRA Safety Advisory No. 2015-02

- Information Requirements Related to the Transportation of Trains Carrying Specified Volumes of Flammable Liquids asks for information to be readily available and reported to the FRA within 90 minutes of an incident.
(https://www.fra.dot.gov/eLib/details/L16321#p2_z5_gD_lSO_lSD_lSA_krail)

April 2015: PHMSA Safety Advisory No. 15-7

- Emergency Response Information Requirements to remind hazardous materials shippers and carriers of their responsibility to ensure that current, accurate and timely emergency response information is immediately available to first responders.
(http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/PHMSA_Notice_15_7_Emergency_Response_Info_Requirements.pdf)

May 2015: DOT announces Final Rule - Enhanced Tank Car Standards and Operational Controls for High-Hazard Flammable Trains

- To strengthen the safe transportation of flammable liquids by rail including tank car standards, operational controls, and new braking standards. (http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/HHFT_Final_Rule.pdf)

November 2015: FRA Safety Advisory No. 2015-05

- Addressing Rail Head Surface Conditions Identified during the Internal Rail Inspection Process
- FRA recommends that each track owner: (7) Review its current engineering instructions to ensure that the procedures are consistent with the industry standard for rail replacement and repair, particularly in track over which passengers or large quantities of ethanol, crude oil, or other hazardous materials are transported. (p. 9 - https://www.fra.dot.gov/eLib/details/L17201#p1_z5_gD_lSO_lSD_lSA_krail)

December 2015: Congress passes the FAST Act (http://www.fhwa.dot.gov/fastact/), which includes numerous provisions supported by the freight railroad industry related to rail safety generally, emergency response training and the safe transport of flammable liquids by rail.

- Phase-Out of All Tank Cars Used to Transport Class 3 Flammable Liquids. Adds a new section that would require ALL railroad tank cars used to transport Class 3 flammable liquids to meet the DOT-117 or DOT-117R specifications, regardless of train composition. Provides for a phase-out schedule for:
  - tank cars carrying Class 3 flammable service, including crude oil (1 January 2018 for non-jacketed DOT-111 tank cars, 1 March 2018 for jacketed DOT-111 tank cars, 1 April 2020 for non-jacketed CPC-1232 tank cars, and 1 May 2025 for jacketed CPC-1232 tank cars);
  - (2) for tank cars carrying ethanol (1 May 2012 for non-jacketed and jacketed DOT 111s, 1 July 2023 for non-jacketed CPC-1232 tank cars, and 1 May 2025 for jacketed CPC-1232 tank cars;
  - (3) for transport of Class 3 flammable liquids in Packing Group I (other than those specified under (1) and (2) the deadline is 1 May 2025; and for
  - (4) Class 3 flammable liquids in Packing Groups II and III (other than those already covered above) the deadline is 1 May 2029.
  - Deadlines for (3) and (4) may be extended by the Secretary of Transportation for up to 2 years upon a finding of insufficient shop capacity.
- Thermal blankets. Requires w/in 6 months that the Secretary issue regulations to require that each tank car built to meet DOT-117 specs and each non-jacketed tank car modified to meet the DOT-117R specs be equipped with an insulating blanket at least ½ " thick.
- Top Fitting Protections. Requires legacy tank car retrofit fittings for pressure relief valves.
- Study and Testing of ECP brakes. Requires the Comptroller General to conduct an independent evaluation of ECP brakes. Specifies requirements of that study. Requires report w/in 18 months. Requires USDOT to conduct testing pf ECP brakes with NAS and specifies conditions of that testing framework. Requires w/in 6 months after receiving results of that testing whether ECP benefits outweigh costs. If ECP brakes

are justified, then USDOT published reasons for that determination. If not, then ECP brake system requirements are repealed.

- Comprehensive Oil Spill Response Plans. Requires w/in 6 months that the Secretary issue regulations to require any RR carrier transporting a Class 3 flammable liquid to maintain a comprehensive oil spill response plan. Specifies contents of that plan. USDOT may provide a copy of a redacted version of that plan to persons requesting it in writing. Protections from disclosure related to FOIA requests. Requires Secretary to consult with States to determine whether there are specific concerns that should be taken into account when developing regulations called for in the bill for railroad carriers to maintain comprehensive oil spill response plans.
- Information on High Hazard Flammable Trains. Requires w/in 90 days that the Secretary issue regulations to require railroads to provide information on high-hazard flammable trains to State emergency response commissions consistent with EO Docket DOT-OST-2014-0067 and include appropriate protections from public release of proprietary information and security-sensitive information (includes categories described in sec. 1520.5 (a) of title 49).

2016

July 2016: PHMSA issues notice of proposed rulemaking (NPRM) on oil spill response plans and information sharing for high-hazard flammable trains. (https://www.federalregister.gov/articles/2016/07/29/2016-16938/hazardous-materials-oil-spill-response-plans-and-information-sharing-for-high-hazard-flammable)

*In addition, several annual appropriations bills included the following crude-by-rail related provisions:

- Mandated comprehensive oil spill response plans
- Provided funding for a new Short Line Railroad Safety Institute for safety training for short line railroads transporting crude and ethanol
- Provided additional funding for new hazardous materials and rail safety inspectors
- Provided eligibility for crude-by-rail training and response through the emergency preparedness fund

Additional Voluntary Actions

August 2013: **Rail industry voluntary risk-reduction procedures:** Long standing best practices for special handling of Key Trains extended to crude and ethanol shipments

- *Key Train Definition: One or more loads of TIH/PIH materials, 20 or more tank loads of any hazardous materials*

Special handling for key trains:

- Lower Speeds: Nationwide speed restrictions of 50 mph for all key trains
- Unattended Trains:
  - Crude oil trains left unattended require specific job safety briefing between train crew and train dispatcher
  - Locomotive Cab Securement: Key Trains left unattended have reverser removed and cab doors locked
- BNSF: More restrictive handling of trackside equipment detection exceptions and 'emergency braking' events

November 2013: The Association of American Railroads (AAR) again urges DOT to improve federal tank car regulations and require all tank cars transporting hazardous flammable liquids such as crude oil be retrofitted or phased out of crude service.

- This follows actions beginning in August 2009 that began discussions and processes to upgrade industry tank car standards that would exceed the safety standards of DOT-111s. The AAR formally petitioned PHMSA to implement tougher tank car specifications for DOT-111 tank cars used for crude oil and other hazardous materials (hazmat) in March 2011. In August 2011, in the absence of any announcement by the U.S. Department of Transportation (DOT), the AAR Tank Car Committee adopts industry construction specifications for new tank cars and the stronger CPC-1232 design becomes the standard for all tank cars built after October 2011.

October 2014: The rail industry releases its AskRailTM (www.AskRail.us) mobile application, which is an additional tool for emergency responders to access tank car information when responding to an incident.

March 2015: BNSF-specific Voluntary Actions for additional special handling for key trains:

- Lower Speeds: 35 mph for all crude oil trains through municipalities of 100k or larger
- Increased Trackside Safety Technology
  - HBD spacing of 10 miles on crude routes that parallel critical waterways
  - Key Train stopped by HBD must set-out the indicated car
  - Key trains with Level II Wheel Impact Load Detector (WILD) defect (120-140 Kilopound (Kips)) will be handled as a Level I defect (immediate set-out)
- Increased rail detection frequencies and increase the rail detection testing frequencies along critical waterways (BNSF currently at 2x FRA frequency; going to 2.5x with this change)

Emergency Response Training

The Rail Industry is constantly working with first responders as part of its ongoing commitment to the safety of the communities we serve all across the country and have been doing so for decades through a number of different sources. BNSF alone has trained more than 65,000 emergency responders since 1996. In past years BNSF trained an average of 3,500 local emergency responders each year in communities across the network.

○