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SPENT NUCLEAR FUEL

Legislative, Technical, and Societal Challenges to Its Transportation

Statement of Frank Rusco, Director, Natural Resources and Environment

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Highlights of GAO-16-121T, a testimony before the Subcommittee on Environment and the Economy, Committee on Energy and Commerce, House of Representatives

Why GAO Did This Study

Spent nuclear fuel—the used fuel removed from commercial nuclear power reactors—is an extremely harmful substance if not managed properly. The nation's inventory of spent nuclear fuel has grown to about 72,000 metric tons currently stored at 75 sites in 33 states, primarily where it was generated.

Under the Nuclear Waste Policy Act of 1982, DOE was to investigate Yucca Mountain, a site about 100 miles northwest of Las Vegas, Nevada, for the disposal of spent nuclear fuel. DOE terminated its work at Yucca Mountain in 2010 and now plans to transport the spent nuclear fuel to interim storage sites beginning in 2021 and 2024, then to a permanent disposal site by 2048. Transportation of spent nuclear fuel is a major element of any policy adopted to manage and dispose of spent nuclear fuel.

This testimony discusses three key challenges related to transporting spent nuclear fuel: legislative, technical, and societal. It is based on reports GAO issued from November 2009 to October 2014.

What GAO Recommends

GAO is making no new recommendations.

View GAO-16-121T. For more information, contact Frank Rusco at (202) 512-3841 or ruscof@gao.gov.

What GAO Found

Based on its prior work, GAO found three key challenges related to the transportation of spent nuclear fuel: legislative, technical, and societal.

- **Legislative challenges**. As GAO reported in November 2009, August 2012, and October 2014, DOE does not have clear legislative authority for either consolidated interim storage or for permanent disposal at a site other than Yucca Mountain. Specifically, provisions in the Nuclear Waste Policy Act of 1982 that authorized the Department of Energy (DOE) to arrange for consolidated interim storage have either expired or are unusable. For permanent disposal, GAO reported in October 2014 that the amendments to the Nuclear Waste Policy Act of 1982 directed DOE to terminate work on sites other than Yucca Mountain. Without clear authority, DOE cannot site an interim storage or permanent disposal facility and make related transportation decisions for commercial spent nuclear fuel.
- **Technical challenges**. As GAO reported in October 2014, experts identified technical challenges that could affect the transportation of spent nuclear fuel. These challenges could be resolved, but it would take time and could be costly. Specifically, GAO reported that there were uncertainties about the safety of transporting what is considered to be high burn-up spent nuclear fuel—newer fuel that burns longer and at a higher rate than older fuel—because of potential degradation while in storage. GAO also reported that guidelines for storage of spent nuclear fuel allow higher temperatures and external radiation levels than guidelines for transportation, rendering some spent nuclear fuel not readily transportable. In addition, GAO reported that the current transportation infrastructure, particularly for a mostly rail option of transportation—which is DOE's preferred mode—may not be adequate without procuring new equipment and costly and time-consuming upgrades on the infrastructure.
- **Societal challenges**. As GAO reported in October 2014, public acceptance is key for any aspect of a spent nuclear fuel management and disposition program—including transporting it—and maintaining that acceptance over the decades needed to implement a spent fuel management program is challenging. In that regard, GAO reported that in order for stakeholders and the general public to support any spent nuclear fuel program—particularly one for which a site has not been identified—there must be a broad understanding of the issues associated with management of spent nuclear fuel. Also, GAO found that some organizations that oppose DOE have effectively used social media to promote their agendas to the public, but that DOE had no coordinated outreach strategy, including social media. GAO recommended that DOE develop and implement a coordinated outreach strategy for providing information to the public on their spent nuclear fuel program. DOE generally agreed with GAO's recommendation.

Chairman Shimkus, Ranking Member Tonko, and Members of the Subcommittee:

I am pleased to be here today to discuss our work on issues related to transportation of commercial spent nuclear fuel. Spent nuclear fuel—used nuclear fuel that has been removed from the reactor core of a nuclear power reactor[1]—is an extremely harmful substance if not managed properly. Without protective shielding, its intense radioactivity can kill a person who is directly exposed to it or cause long-term health hazards, such as cancer. In addition, if not managed properly, or if released by a natural disaster or an act of terrorism, it could contaminate the environment with radiation. The nation's inventory of spent nuclear fuel from commercial nuclear power reactors—which amounts to about 72,000 metric tons— is stored at 75 sites in 33 states, generally where it was generated. The spent nuclear fuel is stored either wet in pools of water or dry in storage systems that typically consist of stainless steel canisters within protective casks. Dry storage systems are designed with thick steel and concrete walls to provide radiation shielding and passive pathways for removal of spent nuclear fuel decay heat, such as air vents in the casks. Transporting the spent nuclear fuel anywhere depends on the policy that is ultimately put into place for management and final disposition of the spent nuclear fuel.

National policy for the disposition of spent nuclear fuel dates to the passage of the Nuclear Waste Policy Act of 1982 (NWPA), which made disposal of spent nuclear fuel a federal responsibility.[2] NWPA directed the Department of Energy (DOE) to investigate sites for a permanent repository. In 1987, Congress amended the act to direct DOE to focus its

[1]Spent (or used) nuclear fuel can no longer efficiently generate power in a nuclear reactor. However, it is potentially a resource because it can be reprocessed to separate out uranium and plutonium to be used again as fuel in a reactor. Reprocessing, however, still results in high-level radioactive waste that requires disposal, and the United States does not currently reprocess spent nuclear fuel from commercial nuclear power reactors. The federal government generates spent nuclear fuel from power, research, and navy shipboard reactors. The U.S. Nuclear Regulatory Commission considers spent nuclear fuel that is accepted for disposal to be high-level radioactive waste. High-level radioactive waste also includes by-products of weapons production and other defense-related activities generated from reprocessing spent nuclear fuel. The scope of this statement only includes commercial spent nuclear fuel.

[2]Pub. L. No. 97-425 §§ 112, 113. NWPA also addressed disposal of high-level radioactive waste other than spent nuclear fuel.

efforts only on a site at Yucca Mountain, Nevada, about 100 miles northwest of Las Vegas. In 2008, DOE submitted a license application for a repository at Yucca Mountain to the Nuclear Regulatory Commission (NRC), which is responsible for regulating storage, transportation, and disposal of spent nuclear fuel from commercial nuclear power reactors. Then, in a change of policy in 2009, the Secretary of Energy said that a repository at Yucca Mountain was not a workable option and, in 2010, DOE terminated its efforts to license a repository there. In 2010, DOE chartered the Blue Ribbon Commission on America's Nuclear Future to recommend a plan for management and disposal of spent nuclear fuel. In January 2012, the Blue Ribbon Commission issued its report.[3] Among other things, the commission recommended that DOE consider consolidated interim storage of spent nuclear fuel and develop a consent-based approach to locating or establishing (or "siting") future spent nuclear fuel management facilities. In January 2013, DOE issued a strategy for managing spent nuclear fuel in response to the commission's recommendations.[4] The strategy calls for the federal government to begin accepting spent nuclear fuel for management at a pilot interim storage facility by 2021 and at a larger consolidated interim storage facility by 2025, then begin disposal at a permanent repository by 2048. According to the strategy, it represents "an initial basis for discussions among the Administration, Congress and other stakeholders on a sustainable path forward for disposal" of spent nuclear fuel and other types of high-level radioactive waste.

Over the past decade, we have issued a number of reports related to the management of spent nuclear fuel. My testimony today discusses the three key challenges related to transporting spent nuclear fuel that we have identified in our prior work. Generally speaking, challenges related to transportation fall into one of three categories: legislative, technical, or societal. I will discuss each of these categories. This testimony is based

[3]Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy (Washington, D.C.: Jan. 26, 2012).

[4]DOE, *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*, (Washington, D.C.: January 2013).

on reports we issued from November 2009 to October 2014. [5] In particular, I will be highlighting our October 2014 report on spent nuclear fuel management. For this work, we reviewed documents and interviewed officials from DOE and NRC regarding their regulatory roles related to spent nuclear fuel management. In addition, we obtained input from experts and stakeholders in spent nuclear fuel management.[6] A detailed discussion of our scope and methodologies can be found in each of our published reports. We conducted the work that this testimony is based on in accordance with generally accepted government auditing standards. Those standards require that we plan and perform audits to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

The transportation of large amounts of spent fuel to an interim storage or permanent disposal location is inherently complex and the planning and implementation may take decades to accomplish. The actual time it would take depends on a number of variables including distance, quantity of material, mode of transport, rate of shipment, level of security, and coordination with state and local authorities. For example, according to officials from a state regional organization we interviewed and the Blue Ribbon Commission report, transportation planning could take about 10 years, in part because routes have to be agreed upon, first responders

[5]For example, see GAO, Nuclear Waste Management: Key Attributes, Challenges, and Costs for the Yucca Mountain Repository and Two Potential Alternatives, GAO-10-48 (Washington, D.C.: Nov. 4, 2009); Yucca Mountain: Information on Alternative Uses of the Site and Related Challenges, GAO-11-847 (Washington, D.C.: Sept. 16, 2011); Commercial Nuclear Waste: Effects of a Termination of the Yucca Mountain Repository Program and Lessons Learned, GAO-11-229 (Washington, D.C.: Apr. 8, 2011); Spent Nuclear Fuel: Accumulating Quantities at Commercial Reactors Present Storage and Other Challenges, GAO-12-797 (Washington, D.C.: Aug. 15, 2012); Commercial Spent Nuclear Fuel: Observations on the Key Attributes and Challenges of Storage and Disposal Options, GAO-13-532T (Washington, D.C.: Apr. 11, 2013); and Spent Nuclear Fuel Management: Outreach Needed to Help Gain Public Acceptance for Federal Activities That Address Liability, GAO-15-141. (Washington, D.C.: Oct. 9, 2014).

[6]In total, we interviewed over 90 individuals, including federal officials, who represented a wide range of viewpoints and expertise. However, our selection of experts is non-generalizable, in that opinions cannot be generalized to other experts or tallied, either within or across types of expertise.

have to be trained, and critical elements of infrastructure and equipment need to be designed and deployed.

Legislative Challenges to Transporting Spent Nuclear Fuel

As we previously reported, DOE does not have clear legislative authority for either consolidated interim storage or for permanent disposal at a site other than Yucca Mountain and, as such, there is no facility to which DOE can transport commercial spent nuclear fuel. Without clear authority, DOE cannot make the transportation decisions necessary regarding commercial spent nuclear fuel.

Specifically, as we reported in November 2009, August 2012, and October 2014, provisions in NWPA that authorize DOE to arrange for consolidated interim storage have either expired or are unusable because they are tied to milestones in the development of a repository at Yucca Mountain that have not been met.[7] DOE officials and experts from industry we interviewed in October 2014 agreed with this assessment, and noted that the federal government's ability to site, license, construct, and operate a consolidated interim storage facility not tied to Yucca Mountain depends on new legislative authority.

For permanent disposal, we reported in April 2011,[8] that developing a permanent repository other than Yucca Mountain will restart the likely time-consuming and costly process of siting, licensing, and developing such a repository and it is uncertain what legislative changes might be needed, if any, to develop a new repository. In part, this is because NWPA, as amended, directs DOE to terminate all site specific activities at candidate sites other than Yucca Mountain.

[7]GAO-10-48, GAO-12-797, GAO-15-141.

[8]GAO-11-229.

Technical Challenges to Transporting Spent Nuclear Fuel

As we reported in October 2014,[9] experts identified technical challenges that could affect the transportation of spent nuclear fuel and these challenges could be resolved with sufficient time. The three technical challenges the experts described were (1) uncertainties related to the safety of high burn-up fuel during transportation,[10] (2) readiness of spent nuclear fuel to be transported under current guidelines, and (3) sufficiency of the infrastructure to support transportation.

Before 2000, most fuel discharged from U.S. nuclear power reactors was considered low burn-up fuel and, consequently, the industry has had decades of experience in transporting it. As we reported in October 2014, various reports from DOE, NRC, the Electric Power Research Institute, and the Nuclear Waste Technical Review Board, as well as experts we interviewed, agreed that uncertainties exist on how long high burn-up fuel—used for about 10 years— can be stored and then still be safely transported. Once sealed in a canister, the spent fuel cannot easily be inspected for degradation. We reported that as of August 2014, NRC officials told us that they had analyzed laboratory tests and models developed to predict the changes that occur during dry storage and that the results indicate that high burn-up fuel will maintain its integrity over very long periods of storage and can eventually be safely transported. However, NRC officials said they continued to seek additional evidence to confirm their position that long-term storage and transportation of high burn-up spent nuclear fuel is safe. We also reported that DOE and the Electric Power Research Institute have planned a joint development project to test high burn-up fuel for degradation, but those results will not be available for about a decade.

As we reported in October 2014,[11] because the guidelines governing dry storage of spent nuclear fuel allow higher temperatures and external radiation levels than guidelines for transporting the fuel, some of the spent nuclear fuel in dry storage may not be readily transportable. For example, according to the Nuclear Energy Institute, as of 2012, only about 30 percent of spent nuclear fuel currently in dry storage is cool

[9]GAO-15-141.

[10]Reactor fuel burn-up is a measure of the energy produced by the fuel. High burn-up fuel generally has been in a reactor longer than low burn-up fuel and is defined as having a burn-up higher than 45,000-megawatt days per metric ton.

[11]GAO-15-141.

enough to be directly transportable. For safety reasons, transportation guidelines do not allow the surface of the transportation cask to exceed 185 degrees Fahrenheit (85 degrees Celsius) because the spent nuclear fuel is traveling through public areas using the nation's public transportation infrastructure. NRC's guidelines on spent nuclear fuel dry storage limit spent nuclear fuel temperature to 752 degrees Fahrenheit (400 degrees Celsius). Scientists from the national laboratories and experts from industry we interviewed suggested three options for dealing with the stored spent nuclear fuel so it can be transported safely: (1) leave it to cool and decay at reactor sites, (2) repackage it into smaller canisters that reduce the heat and radiation, or (3) develop a special transportation "overpack" to safely transport the spent nuclear fuel in the current large canisters. However, as we reported in August 2012,[12] spent nuclear fuel stored at reactor sites that had already shut down and dismantled their infrastructure may pose an even more difficult challenge because the ability to repackage the fuel or develop similar solutions may be limited without building additional infrastructure, such as a special transfer facility, or the spent fuel would need to be shipped to a site that had a transfer facility.

According to a 2013 DOE report, the preferred mode for transporting spent nuclear fuel to a consolidated interim storage facility would be rail.[13] However, as we reported in October 2014,[14] several experts from industry pointed out that not all of the spent nuclear fuel currently in dry storage is situated near rail lines; also, one of these experts said that procuring qualified rail cars capable of transporting spent nuclear fuel will be a lengthy process. Storage sites without access to a rail line may require upgrades to the transportation infrastructure or alternative modes of transportation to the nearest rail line. Constructing new rail lines or extending existing rail lines could be a time-consuming and costly endeavor. In addition, an industry official we interviewed noted that if spent nuclear fuel were trucked to the nearest rail line, the federal government would have to develop a safe method of transferring the spent nuclear fuel from heavy haul trucks onto rail cars. In September

[12]GAO-12-797.

[13]See DOE, *Office of Fuel Cycle and Research Development, A Project Concept for Nuclear Fuels Storage and Transportation*, FCRD-NFST-2013-000132 Rev. 1 (June 15, 2013).

[14]GAO-15-141.

2013, DOE completed a preliminary technical evaluation of options available and needed infrastructure for DOE or a new waste management and disposal organization to transport spent nuclear fuel from shut-down sites to a consolidated interim storage facility. According to DOE officials, there was no need to make a decision regarding how best to move forward with the study results because there was, at that time, no site and no authorization to site, license, construct, and operate a consolidated interim storage facility.[15] We also reported in October 2014 that procuring qualified railcars may be a time-consuming process, in part because of the design, testing, and approval for a railcar that meets specific Association of American Railroads standards for transporting spent nuclear fuel.[16]

Societal Challenges to Transporting Spent Nuclear Fuel

As we found in October 2014, public acceptance is key to any aspect of a spent nuclear fuel management and disposition program, including transportation. Specifically, unless and until there is a broad understanding of the issues associated with management of spent nuclear fuel, specific stakeholders and the general public may be unlikely to support any spent nuclear fuel program. In particular, a program that has not yet been developed or for which a site has not been identified may have challenges in obtaining public acceptance. This finding is not new and, in April 2011 and in October 2014 we found reports spanning several decades that identified societal and political opposition as the key obstacles to spent nuclear fuel management.[17] For example, in 1982, the congressional Office of Technology Assessment reported that public and political opposition were key factors to siting and building a repository. The National Research Council of the National Academies reiterated this conclusion in a 2001 report, stating that the most significant challenge to siting and commencing operations at a repository is societal. Our analysis of stakeholder and expert comments indicates the societal and political

[15]DOE, *Preliminary Evaluation of Removing Used Nuclear Fuel from Shutdown Sites*, PNNL-22676 Rev.1 (Sept. 30, 2013).

[16]The American Association of Railroads established the S-2043 standard that sets higher standards for transportation of spent nuclear fuel than for normal rail operations. For example, S-2043 requires on-board safety protection technology unique to spent nuclear fuel shipments and structural upgrades to accommodate the extra weight.

[17]GAO-11-229, GAO-15-141.

factors opposing a repository are the same for a consolidated interim storage facility.

Moreover, we reported in April 2011[18] and October 2014[19] that any spent nuclear fuel management program is going to take decades to develop and to implement and that maintaining public acceptance over that length of time will face significant challenges. We also reported in November 2009, that the nation could not be certain that future generations would have the willingness or ability to maintain decades-long programs we put into place today.[20] Of particular concern is having to transport spent nuclear fuel more than once, which may be required if some spent nuclear fuel is moved to an interim storage facility prior to permanent disposal. Some stakeholders have voiced concerns that because of this opposition to multiple transport events, a consolidated interim storage site may become a de facto permanent storage site.

In October 2014, we reported that according to experts and stakeholders, social media has been used effectively to provide information to the public through coordinated outreach efforts by organizations with an interest in spent nuclear fuel policy. Some of these organizations oppose DOE's strategy and the information they distribute reflects their agendas. In contrast, we reported that DOE had no coordinated outreach strategy, including social media. We concluded that in the absence of a coordinated outreach strategy by DOE, specific stakeholders and the general public may not have complete or accurate information about the agency's activities, making it more difficult for the federal government to move forward with any policy to manage spent nuclear fuel. We recommended that DOE develop and implement a coordinate outreach strategy for providing information to specific stakeholders and the general public on federal activities related to managing spent nuclear fuel—which would include transportation planning. DOE generally agreed with our recommendation.

[18]GAO-11-229.

[19]GAO-15-141.

[20]GAO-10-48.

Chairman Shimkus, Ranking Member Tonko, and Members of the Subcommittee, this concludes my prepared statement. I would be pleased to respond to any questions you may have at this time.

GAO Contact and Staff Acknowledgments

If you or your staff members have any questions about this testimony, please contact me at (202) 512-3841 or ruscof@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this testimony. Karla Springer (Assistant Director), and Antoinette Capaccio, Robert Sánchez, and Kiki Theodoropoulos also made key contributions to this testimony.