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Transporting Spent Nuclear Fuel in the United States:

An Assessment of Current Capabilities and Future Challenges

This issue brief is one in a series prepared by the Bipartisan Policy Center's Nuclear Waste Initiative, which is exploring ways to advance progress toward durable solutions for safely managing and disposing of the nation's inventory of high-level radioactive waste and spent nuclear fuel. This issue brief looks specifically at the challenge of transporting large quantities of spent nuclear fuel from the dispersed reactor sites where it is currently being stored to one or more consolidated storage and/or permanent disposal facilities. Although radioactive materials have been safely transported in the United States and in other countries for several decades, there is little experience with managing transport operations on the scale that would be needed to move the tens of thousands of metric tons of spent nuclear fuel that have been and are still being generated by the U.S. commercial nuclear industry. (The nation's existing inventory of spent nuclear fuel totals approximately 70,000 metric tons; currently operating reactors add approximately 2,000 tons to this total each year. Projections indicate that the existing reactor fleet could generate as much as 140,000 tons of spent fuel—roughly double the current inventory—over its expected lifetime.)

This paper summarizes key points from a more detailed analysis of spent nuclear fuel transport requirements and capabilities in the United States. The discussion is organized around three main topics: (1) hardware and infrastructure challenges; (2) transportation from shutdown reactor sites; and (3) systemic issues, including institutional roles and arrangements, regulatory challenges, and funding. A recurrent theme is the importance of giving states, tribes, and local authorities strong roles in transportation planning, along with the resources necessary to effectively address citizen and stakeholder concerns.

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Transportation Hardware and Infrastructure Barriers

Transporting spent nuclear fuel requires infrastructure, such as roads, railroads, and bridges; it also requires hardware, including casks to hold the spent fuel during transport, special rail cars, and purpose-built equipment to load and unload casks at reactor sites and at storage or disposal sites.

- **Transportation casks:** A variety of dual-purpose storage/transportation canisters have been developed for the dry storage of spent nuclear fuel at reactor sites. In most cases, the casks to transport these canisters have been licensed but not yet built. There are questions as to whether existing dual-purpose canisters will still be transportable after extended periods of storage at reactor sites, especially in the case of high burn-up fuel, which is hotter, and in the case of canisters stored at sites where corrosion is a greater concern, such as near the ocean. Another issue is that spent fuel in canisters is not considered to be an acceptable waste form under the existing Standard Contract between the U.S. Department of Energy (DOE) and nuclear utilities. Unless the Standard Contract is modified by mutual agreement, spent fuel must be retrievable for packaging into a DOE-supplied transportation cask—and this capability no longer exists at reactor sites that have decommissioned their spent fuel pools. The sheer variety of canisters currently in use—some 50 unique types representing 29 different canister "families"—is itself an issue because it significantly complicates not only transport operations, but also handling operations at receiving facilities. In addition, 14 out of the 50 unique canister types currently in use are certified only for storage and not for transport. At present, nine unique cask types are available to transport different canisters—new casks can take two to five years to design and fabricate. For cost and efficiency reasons there has long been interest in developing standardized canisters, but prospects for implementing this idea are unclear given current uncertainty in the waste management program.
- **Railcars:** Specialized railcars are needed that can meet the Association of American Railroads (AAR) Standard S-2043 for the transport of spent nuclear fuel and high-level radioactive waste. Although the U.S. Navy is testing a new railcar that complies with S-2043, developing a railcar that can transport the wide variety of casks in use for commercial spent fuel and getting approval for all the rail cars on the train will be a first-of-its-kind effort. S-2043 is designed to provide a safe cask/car/train system that minimizes the chances of derailment and incorporates additional safety measures, such as on-board, real-time monitoring and buffer cars to separate the locomotive and escort cars from the cask car. Developing railcars that can meet the AAR standard will take time, resources, and institutional commitment. DOE recently issued a request for proposals to start the design process for an S-2403-compliant railcar for spent nuclear fuel.
- **Infrastructure:** The rail, road, and barge infrastructure near existing nuclear power plant sites will need to be evaluated before it can be used to support the large-scale transport of spent nuclear fuel. Rail infrastructure is particularly critical, since this is expected to be the main mode of transport for spent fuel. Not all reactor sites are near rail lines, and many of those that have historically been accessed by short-line rail spurs will need upgrades to tracks and bridges to handle railcars carrying heavy spent fuel loads. Where rail access or rail upgrades are economically infeasible, heavy-haul trucks or barges will have to be used instead, which could require upgrades to roadway infrastructure and/or waterways.
- **Maintenance:** The infrastructure and hardware to transport spent nuclear fuel will need to be maintained. Responsibility for maintaining different elements of the transport system will fall to different entities (for example, rail companies for the rail lines; the responsible waste management entity in the case of transport casks and rail cars).

Transportation of Spent Nuclear Fuel from Shutdown Reactors

Both the Blue Ribbon Commission on America's Nuclear Future (BRC) and DOE have recommended that spent nuclear fuel being stored at shutdown reactor sites be first in line for transfer to consolidated storage or permanent disposal in a geologic repository. Transporting spent fuel from shutdown reactor sites raises a number of issues, including the potential that some of the fuel assemblies are damaged and may require re-analysis and possible repackaging; the need to upgrade certificates of compliance for some canisters before transport casks or impact limiters can be fabricated; the need for changes to the existing Standard Contract for reasons noted previously; and the need to upgrade or build new infrastructure to provide rail, barge, or heavy-haul truck access to the shutdown sites. In addition, several shutdown sites have not maintained the capability to transfer storage canisters to transportation casks. This is likely to be an issue for a growing number of sites as utilities decommission storage pools at shutdown reactors. At present, only two of the nation's 14 shutdown reactor sites have transport casks that have been fabricated and are available; however, these casks do not have impact limiters. Vendors would need to update Nuclear Regulatory Commission (NRC) certificates of compliance for transport casks, as needed, and manufacture the casks—this process is likely to take several years.

Key activities to transport the fuel include assembling project organization and management teams; acquiring casks and ancillary equipment; developing specifications, soliciting bids, issuing contracts, and initiating shipping preparations; procuring AAR Standard S-2043-compliant railcars; procuring off-site transportation services; coordinating with stakeholders; assessing and selecting routes and modes of transport; training transportation emergency-response personnel; outreach and communication with local communities along planned transportation routes; planning for at-site operational interfaces and acceptance, support operations and in-transit security operations; conducting readiness activities; assembling and training workers; and organizing loading for off-site transport.

Systemic Issues

This set of issues encompasses management challenges, institutional roles and responsibilities, regulatory oversight, state and tribal roles, and funding.

- **Management/leadership:** Under current law, DOE is responsible for spent nuclear fuel management and disposal, including transporting spent fuel to consolidated storage facilities and/or a permanent repository site. Both the BRC and DOE itself have recommended that a new organization be formed to take over the nation's nuclear waste management program. Such an organization would also create a single point of contact with responsibility for the waste management program, including transportation, which has been lacking since DOE abolished the Office of Civilian Radioactive Waste Management in 2010. Currently, no formal guidance exists concerning planning for spent fuel transport, although DOE did initiate a Nuclear Fuels Storage and Transportation Planning Project in 2013.
- **Regulatory issues:** Globally, the International Atomic Energy Agency sets transportation safety standards that are used as a basis for many national regulations. Within the United States, several government agencies play a role in regulating commercial spent fuel transport, including the NRC, the U.S. Department of Transportation (DOT), the Pipeline and Hazardous Materials Safety Administration and the Federal Railroad Administration (FRA) within DOT for rail transport, and the Department of Homeland

Security via the Coast Guard for transport over waterways. For example, the NRC is responsible for establishing regulatory requirements for transportation casks, certifying cask designs and issuing certificates of compliance, establishing physical protection requirements for spent nuclear fuel in transit, and establishing requirements to notify state and tribal authorities of future shipments. DOT sets requirements for route selection for both road and rail shipments, vehicle condition and placarding, driver training, package marking, labeling and other shipping documentation, emergency-response information, training, and safety and security plans, including pre-trip security inspections. Because of this division of roles and responsibilities, there is no single point of contact for the regulation of spent nuclear fuel transport.

- **Role of state, tribal, and local governments:** Because they are directly responsible for the health and safety of their citizens and have some authority over shipments that transit their jurisdictions, states, tribes, and local officials will play a role in working with federal agencies to implement spent nuclear fuel transport. This role includes developing emergency-preparedness training and safety-related program elements and enacting laws to address issues not covered by federal regulation. To support this role, the Nuclear Waste Policy Act requires technical assistance and funds for training public-safety officials to be provided to the states through which nuclear waste transits. Associated policies and procedures must be finalized several years prior to shipment. In addition, states and tribes can enforce federal transportation safety standards, determine driver qualifications for truck shipments, ensure safe operation of motor vehicles, and conduct inspection and enforcement activities. For rail, state inspectors who have been trained and certified through the FRA State Participation Program have the same regulatory authority as FRA inspectors. Specific requirements for oversize and overweight highway shipments, including heavy haul, tend to be the purview of the state. States can also inspect shipments that enter their jurisdictions. For truck transport, the Commercial Vehicle Safety Alliance Level VI inspection program is well established and makes it possible for shipments to pass through without the need for in-route inspections.
- **Lack of consistent funding:** Lack of consistent funding has been an issue for the U.S. nuclear waste management program generally, and transportation—which has been viewed as less critical than facility development—has been subject to even greater fluctuations than the program as a whole. Though there is broad consensus that a more stable funding mechanism is needed—the BRC stressed this point, as have the State Regional Groups with which DOE coordinates some of its transportation activities—there is no agreement on a path forward to address the funding issue. Meanwhile, the budget of DOE's Nuclear Fuels Transportation and Storage Planning Project, which is the office responsible for planning for transportation and interaction with stakeholders, was cut by 25 percent between FY2014 and FY2015.

Conclusion

Considerable time, work, and planning is needed to prepare for transporting spent nuclear fuel from reactor sites to consolidated storage or disposal facilities. Substantial infrastructure and hardware investments will be required, and a number of regulatory and legal issues must be addressed. Funding to support the meaningful involvement of states, tribes, and local governments, and to establish strong lines of communication and build trust and confidence with these and other stakeholders, is particularly critical to success.

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