

**LESSONS LEARNED WITH REGULATIONS GOVERNING
SELECTION OF ROUTES FOR SHIPPING SPENT FUEL**

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DOT and USNRC regulations that affect the selection of routes for domestic shipments of spent nuclear fuel are described briefly in Section 1.2.3. Certain provisions of these regulations, relating specifically to the route selection practices relevant to this chapter, are summarized below.

The DOT administers regulations governing the routing of highway shipments of spent nuclear fuel (49 CFR 397.101 and 397.103) that apply to any shipment of a quantity of radioactive material meeting the regulatory definition of “highway route controlled quantity.” These require the following:

- The carrier must operate the vehicle containing the material only over “preferred routes.” Preferred routes include all Interstate System highways, except where the state has designated an alternative route to a particular Interstate System highway segment, and other state-designated routes.
- A state may designate a preferred route for transport of radioactive materials after it conducts a risk analysis and consults with neighboring states, and must notify DOT of the designation.
- Among preferred routes, the carrier must select the route that minimizes time in transit, except that the carrier must select Interstate System bypasses around cities unless the state has designated an alternative.
- The carrier may deviate from preferred routes only for security reasons (as specified in a required security plan or at the direction of the USNRC), for pickup and delivery of shipments, for rest stops, and for emergencies.
- In traveling between the origin and a preferred route and from a preferred route to the destination, the carrier may select either the shortest-distance route or another route that minimizes radiological risk considering accident rates, transit times, population density, activities, time of day, and day of week, provided this route does not exceed the length of the shortest-distance route by more than 25 miles and is less than five times the length of the shortest-distance route.

Literal application of these regulations would practically dictate a unique highway route in many circumstances. The regulation does not explicitly require the carrier to consider risks of individual routes, except in the circumstance that the shortest-distance route is not chosen for travel to a designated highway from the shipment origin or from a designated highway to the destination. Rather, the primary responsibility of the carrier is to keep to the designated preferred route system, and a burden is placed on the states to make whatever adjustments are necessary in the designated route system to ensure safety.

In a Notice of Proposed Rulemaking, DOT explained its justification for the routing regulation as follows (DOT, 1980, p. 7144): “In view of statistics showing lower accident rates and reduced travel times in travel on Interstate highways, this proposal favors use of

the Interstate System. [DOT] believes that in most cases this policy will produce the most significant transportation safety impact reduction and it offers a clear standard for compliance and enforcement purposes.” For quantitative support, DOT cites the USNRC’s transportation EIS (USNRC, 1977; which, DOT states, determined that restricting carriers of large quantities of radioactive materials to Interstate System highways would be a cost-effective measure (DOE, 1980, p. 7149).

For rail shipments of spent fuel, there are no federal regulations governing route selection analogous to the highway routing regulations. As the following section on DOE’s practices for shipping research reactor spent fuel describes, the absence of regulation has not meant in practice that railroads have selected routes for these shipments without government oversight. Historically, DOE has specified rail routes in its contracts with the railroads. The states lack the authority over rail routes that federal regulations give them over highway routes, although DOE has consulted the states on rail route selections.

USNRC regulations (10 CFR 73.37) require that any licensee shipping spent nuclear fuel exceeding a threshold quantity obtain the USNRC’s approval of shipment routes. Normally, the transportation services contractor arranging a spent fuel shipment submits the planned route for USNRC review. USNRC approval of a route is valid only for shipments by the party submitting the application and for a term of two years. Rail as well as highway routes must be submitted for review.

The USNRC route review is among the regulatory requirements intended to “minimize the possibilities for radiological sabotage ... [and] ... [f]acilitate the location and recovery of spent fuel shipments that may have come under the control of unauthorized persons” (10 CFR 73.37 (a)). The regulation does not specify the security factors that the USNRC takes into account in its review. USNRC staff reported to the committee that proposed routes are examined in detail and that the review considers travel time and distance and, for highway shipments, adequacy of provisions for safe havens, that is, preplanned locations where the vehicle may stop in case of an emergency and receive protection by police or other security forces.

Shipments of spent fuel made directly by DOE or by contractors to DOE are not legally subject to USNRC regulations because DOE is not a licensee. The regulations do apply to shipments performed by non-DOE operators of research reactors, including universities, private firms, and other government agencies. These operators are USNRC licensees. Certain domestic shipments of foreign research reactor spent fuel are carried out by contractors to the foreign operators of the research reactors, and these are subject to USNRC regulations as well. For shipments of foreign research reactor spent fuel carried out by DOE contractors, DOE as a matter of policy seeks USNRC approval of the routes (DOE, 2003a, p. 6; DOE, 2003b, p. 4).

SELECTION OF ROUTES FOR SHIPPING RESEARCH REACTOR SPENT FUEL

As specified by the Congress, the charge in this task is to analyze how DOE

- Selects potential routes for shipment of research reactor spent fuel to DOE facilities;
- Selects a route for a specific shipment;
- Assesses risks of such a route; and
- Considers proximity to population, current traffic and accident data, road quality, emergency response capabilities, and proximity to gathering places.

The questions about routing of shipments of research reactor spent fuel, and also the points of contention in the controversies about specific shipments that led to the congressional request for this study, focus on methods of comparing risks of the selected routes with risks of alternatives and the use of such comparisons in routing decisions.

The steps that were followed by DOE to select routes for shipment of foreign research reactor spent fuel are the same steps that DOE expects to follow in its program to ship commercial spent nuclear fuel to a federal repository: first, development of a plan for the program that identifies sets of potential or candidate routes and, then, selection of a specific route at the time of each shipment, with each step guided by, among other considerations, an assessment of the risks of the favored routes versus alternative routes and modes. These steps are dictated by DOE's general policies regarding transportation of spent nuclear fuel (DOE, 2002b) and are consistent with DOE statements concerning its plans for selecting routes for shipping spent fuel to a federal repository. DOE's experience with research reactor spent fuel shipments therefore has general relevance to commercial spent fuel transportation, although the relevance is limited because the scales of the two activities differ greatly. The foreign research reactor spent fuel transport program is a small-quantity shipping program, whereas the transport program to the federal repository will be a large-quantity shipping program.

The subsections below address the questions posed to the committee in the congressional study charge: The first is about procedures for selecting potential routes; the second, about selecting routes for specific shipments; and the third, about consideration of population, traffic, accident, and emergency response capabilities in route selection. DOE's methods of assessing risk are described in each of these subsections. The descriptions refer primarily to procedures for selecting routes for shipping spent fuel from foreign research reactors, which is the largest category of shipments for which DOE has direct responsibility. The final subsection identifies differences in practices for transport of spent fuel from domestic research reactors.

State Working Groups and Transportation Plans

After publication of the ROD, DOE convened two state working groups to serve as forums for consultation with the states and tribes along potential foreign research reactor shipping routes from Charleston to Savannah River and from Savannah River to Idaho National Laboratory. The consultations were to cover road conditions, emergency response capabilities and needs, and any specific state highway route designations. This approach followed the model of consultation on radioactive waste transportation that had been developed for earlier DOE activities, especially the Waste Isolation Pilot Plant (WIPP) program.

The Foreign Research Reactor Spent Nuclear Fuel Transportation Working Group addressed plans for transportation from Charleston to Savannah River and involved South Carolina officials from health, law enforcement, and emergency response agencies. It was organized with the cooperation of the Southern States Energy Board, an organization formed by an interstate compact of 16 southeastern states providing for cooperative energy and environmental programs.

For highway transportation in South Carolina, DOE originally proposed to the working group the predominantly Interstate System route dictated by DOT routing regulations. This route had been evaluated in the EIS (DOE, 1996a, p. E4) and cited in the Web version of the ROD (DOE, 1996c). The state rejected this route because it is indirect, passes near the urban areas of Columbia and Augusta, and includes an interchange with a high accident frequency. The state proposed another highway route, which was adopted in the Charleston-Savannah River transportation plan (DOE, 2003b, Appendix 8.1). The alternate route follows mostly roads other than Interstate System highways but is shorter than the Interstate System route, avoids the cities of Columbia and Augusta, and avoids the high-accident interchange. DOT has not published this route as a state-designated preferred route. Selection of the alternate route appears to have been based primarily on the local knowledge and professional judgment of the officials involved, although state officials report that a comparison of accident rates on the routes was carried out.

Because the 1996 ROD had declared that rail would be the preferred mode, the DOE-South Carolina working group began by developing procedures for rail shipments. Whereas the states have authority under federal law to regulate highway routes of spent fuel shipments, they have no legal control over rail routes. Nonetheless, primary and alternate rail routes for Charleston-Savannah River shipments, as well as safety procedures, were defined by DOE after consultation with the state and discussions involving the railroad and the Federal Railroad Administration. Rail shipments have been by dedicated train, with routes specified in DOE contracts with the carrier. It is part of DOE's arrangement with the state that rail will be used for all shipments from Charleston to Savannah River except that truck may be used when four or fewer packages are awaiting transport. Since 1996, 20 of the 23 shipments from Charleston to Savannah River (most comprising multiple packages) have been by rail.

To consult with the states and tribes on Savannah River-to-Idaho National Laboratory shipments, DOE convened the Cross-Country Transportation Working Group, with support from the Southern States Energy Board and the Council of State Governments-Midwestern Office, an association of midwestern states that coordinates those states' interactions with DOE on radioactive materials transportation. The membership of the working group included representatives of 17 states, two tribal nations, the state regional organizations, and federal agencies (Huizenga et al., 1999). At DOE's request, the state members were gubernatorial appointees.

DOE initially proposed four highway routes to the group, developed with the HIGHWAY model and similar to the "representative routes" in the EIS. These routes were modified according to recommendations of working group members, and one of the four (the green route, departing South Carolina to the north, through North Carolina) was eliminated because of the group's concerns about weather and terrain. Some of the state recommendations were based on more detailed examinations of the physical characteristics of the routes than DOE had carried out. For example, South Carolina recommended an improved access route from Savannah River to the Interstate System. The states also favored routes that had been used earlier for radioactive waste shipments, because emergency responders along these routes had already received training.

During this consultation process, DOE analyzed the transportation risks of the alternative routes using RADTRAN (Weiner and Mills, 1999) and presented the results to the working group. These show small differences among the routes in risks of radiation exposure (ranging from 1 LCF in 10 million trips for the route with the lowest radiation risk to 1 LCF in 6 million trips for the route with the highest risk) and of truck accidents (ranging from 1 fatal truck accident in 16,000 trips to 1 truck accident in 13,500 trips). There is no indication that these estimates had any influence on the initial specification of the routes or on subsequent selection of routes for individual shipments. The green route, the route dropped from consideration because of objections from several states, appears in the RADTRAN estimates to have the lowest risk of radiation exposure fatalities, because it has the lowest total population in proximity to the route, and the second lowest risk of fatalities from truck crashes. It should be noted that many of the working group objections to DOE route proposals arose from particular local conditions that are not taken into account in the RADTRAN estimates. For example, RADTRAN uses state-level average truck accident rates rather than rates specific to individual highway sections.

The understandings that DOE reached with the states and tribes in the working groups regarding routes and transportation procedures for foreign research reactor shipments to Savannah River and Idaho National Laboratory were documented in the two transportation plans (DOE, 2003a, 2003b). These include the following:

- Maps specifying the highway and (for shipments from Charleston to Savannah River) rail routes to be used

- Definitions of the responsibilities of all federal and state agencies involved and of commercial carriers
- Specification of advance notification and shipment tracking practices
- Specification of additional safety practices, including state-by-state vehicle inspection procedures and use of dedicated trains for rail shipments
- A public communications plan
- An emergency response plan that specifies the responsibilities of the parties in the event of an incident during transport
- In the plan for shipments from Savannah River to Idaho National Laboratory, a list of special events and of urban areas with rush hours that the states and tribes asked DOE to avoid in scheduling shipments; DOE agreed to minimize conflicts and to notify the state if a conflict were to arise

Routes for Specific Shipments: Foreign Research Reactor Spent Fuel

All recent and currently planned domestic foreign research reactor spent fuel shipments have been from Charleston to Savannah River or from Savannah River to Idaho National Laboratory. Packages destined for Idaho National Laboratory normally would arrive at Charleston by sea, be shipped by rail or truck to Savannah River, and remain at Savannah River no more than a few days before being shipped by truck to Idaho National Laboratory (DOE, 2003a, p. 9). Selection of a route for a specific shipment therefore entails deciding which of the potential routes published in the two DOE plans for these movements (DOE, 2003a,b) will be used, and checking to determine if any immediate circumstances require modifying the route.

A transportation services contractor organizes transport and all related activities, with oversight from DOE. For shipments originating in high-income economy countries,⁵ the foreign reactor operator hires the contractor. For shipments from other than high-income economy countries, DOE hires the contractor. The contract specifies that transportation must comply with the provisions of the DOE transportation plan (DOE, 2003a, pp. 5–9). The contractor is responsible for obtaining approval of the intended route from the USNRC, according to the regulatory requirements of 10 CFR 73.37.

DOE officials reported to the committee that in selection of routes for specific shipments, the following factors are considered:

- DOT highway route selection regulations
- State and tribal advice regarding
 - Road conditions and construction zones
 - Planned events (e.g., sporting events or festivals)
 - Emergency response and radiological training needs
 - Shipment and truck inspection requirements
 - Rush hour periods through cities

- RADTRAN accident analysis
- Shipment schedule, particularly the season of the year
- Number and type of packages to be shipped
- Possibility of coordination of the foreign research reactor shipment with shipments from DOE or university facilities
- Any other factor that could affect shipment transit time

DOE reported that the route selection process leads to a recommendation to the Assistant Secretary for Environmental Management for approval.

A state may not attempt to unduly interfere with interstate commerce in order to avoid a successful legal challenge to a state law. Also, if comprehensive federal legislation exists in a particular area, a state is preempted from attempting to legislate in that area. When federal legislation only partially occupies a particular field, a state may create legislation in that area so long as it does not conflict with existing federal law.

In the committee's judgment, DOE's procedure for selecting transportation routes in the foreign research reactor spent fuel program appears on the whole to be adequate and reasonable. The elements of this procedure have been the following:

- A quantitative risk analysis of representative routes and alternative modes is conducted as part of an EIS, to judge whether the transportation activity meets a threshold standard of acceptable safety (but not for the purpose of choosing among alternative routes). In the case of research reactor spent fuel, these evaluations have always concluded that risks are very low.
- Potential routes are identified following DOT regulations (for highways) in consultation with states and tribes and in discussions with railroads, states, and tribes for rail routes.
- The actual route used for an individual shipment is selected from among the potential routes, again in consultation with states and tribes, after a review of immediate circumstances (e.g., special events, road construction). Actual route choices also have reflected DOE's desire to avoid conflicts and minimize delays.

This procedure reflects DOE's position (which is consistent with DOT regulations) that the states and tribes are competent and responsible for selecting highway routes and, in particular, for having detailed and current local knowledge about accident rates, road and traffic conditions, and events. The route selection process may be described as risk-informed; that is, quantitative estimates of risks are considered alongside other factors, including costs, administrative feasibility, local preferences, and inevitable political considerations. Route selection is not determined wholly by a risk assessment because DOE recognizes that these other valid factors must also be considered.

Experience with research reactor spent fuel shipments indicates that selection of highway routes by complying with DOT highway routing regulations is a reasonable substitute for a process that selects routes through quantitative risk assessments that explicitly compare alternative routes, provided that the shipper actively and systematically consults with the states and tribes along potential routes and that states comply with DOT route designation regulations. Analyses indicate that differences in risk among routes attributable to the factors that current models represent adequately (e.g., distance and population density) are relatively small. Up-to-date, comprehensive, and detailed data on accident rates and other risk factors that would be required for more refined quantitative comparisons of alternative routes do not exist. Factors that cannot readily be incorporated into a quantitative assessment (e.g., emergency response capabilities, schedules of road construction and other transient events) may be predominant influences on differences in risk among alternative routes and must therefore be considered alongside the quantitative risk estimates.

Information on local transport conditions supplied by states and tribes is an essential element in route selection decisions. Detailed state reviews allow for the identification of high-accident-rate segments of the Interstate System as well as the identification of acceptable non-Interstate System routes that would substantially reduce mileage and travel time. Judgments of state officials on such matters are most useful when supported with quantitative evidence.

In controversies over routing, states and others repeatedly have criticized DOE for failure to carry out comparative quantitative risk evaluations of alternative routes. DOE could respond to this concern by developing improved risk evaluation tools for comparative route analysis and by giving the results of such analyses appropriate weight in decision making.

In planning routes for the foreign research reactor program, trade-offs were made whose safety implications were not explicitly analyzed. For example, instances were described to the committee in which route selection was influenced by state officials' preference for one proposed route over an alternative with a lower population density that was believed to have a higher accident rate, without a quantitative assessment of the risk implications. Also, states have sometimes expressed preference for routes on which emergency response personnel have already received the necessary training. This could favor the selection of routes through more densely populated areas if emergency responders there have higher levels of training. As a final example, complying with schedule restrictions on shipments might conceivably entail delaying a vehicle en route rather than driving through a city during peak traffic periods (rush hour). DOE does not have a methodology for quantitatively evaluating the risk implications of such trade-offs.