Any Way to Run a Railroad: Implications of Dedicated Trains

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ABSTRACT

The DOE recently issued a policy statement that it would use dedicated trains for most waste shipments to Yucca Mountain. Prior uncertainty about use of dedicated trains for Yucca Mountain rail shipments prevented an assessment of the likely impacts. This paper examines the controversy over the use of dedicated trains and evaluates the national impacts of shipping waste to Yucca Mountain using dedicated trains on the Union Pacific's preferred rail system. The national impacts of the routing are reported as route miles through three land use types: Rural, Urban and Census Places.

INTRODUCTION

The Department of Energy's (DOE) recent decision to use dedicated trains as the usual method of shipping High-Level Radioactive Waste (HLW) and Spent Nuclear Fuel (SNF) to Yucca Mountain makes it possible to examine the national effects of this proposal [1]. This paper examines the desirability of using dedicated trains using the recently released National Academy of Science (NAS) report: "Going the Distance?" to recapitulate the arguments in favor of using dedicated trains instead of general freight [2]. The reasons cited by the NAS report that favor use of dedicated trains are: operational, safety, security, communications, and planning, programmatic and public preference. This paper examines each of these advantages. It concludes by describing the national impact of the shipping program.

It is important to recognize that while the DOE and NAS and US Dept. of Transportation expressions of support and operational desirability of dedicated rail shipment to Yucca Mountain are sincere and important, they remain purely hypothetical. There is no rail access to Yucca Mountain. The estimated cost to build this rail access doubled last year and now exceeds $2 billion. Currently, the only feasible way to move SNF and HLW to Yucca Mountain is legal weight truck.

It is also important to note that the Federal Government's experience with shipping SNF and HLW by rail is primarily confined to dedicated trains. The Foreign Research Reactor Program

and the Three Mile Island shipments to Idaho both used dedicated trains. The Naval Fuel shipment program until 1996 used dedicated trains. If a railroad is constructed to Yucca Mountain, the use of dedicated rail will result in a number of benefits for the DOE. These benefits are discussed below.

Operational

The operational advantages of dedicated trains are very straightforward. Instead of intermittent individual shipments traveling simultaneously on a relatively large number of routes, it will be possible to assemble the shipments into three to five cask consists, and ship them across country without the delay or the complexities of removing individual waste casks from general freight traffic.

Fig. 1. General freight in the Proviso Rail Yard Chicago, Ill

Dedicated rail shipments can move unimpeded through the national rail system without intermingling with other rail traffic. Scheduling the flow of waste to Yucca Mountain will become more predictable by combining individual cask movements into three or five cask dedicated trains. A remaining uncertainty is due to the Standard Contracts between the utilities and DOE. How the DOE manages receipt of fuel from the utilities is an important, unresolved issue.

Safety

Dedicated trains moving SNF and HLW may be expected to be involved in fewer accidents due to the uniform speeds that permit the train to move at a relatively constant speed without frequent braking and acceleration. The use of dedicated trains will also reduce accident frequency by enabling railroads to more effectively manage their system to ensure the train avoids congested

locations. For the same reason, these dedicated trains will be able to avoid conflicts with other types of cargo.
Accident severity may also be decreased due to the uniform traveling speed, which may prevent accidents capable of challenging a spent fuel cask. Additionally, extra route controls and safety precautions can also be deployed when routes are consistently used. Even additional equipment may be deployed at locations en route, in order to insure faster response and speedy recovery from an accident.

Security
The security of these shipments will be improved due to the tighter controls exercised over the shipments en route. The ability to effectively select and screen train crews will also be enhanced by using dedicated trains. By aggregating shipments and hence reducing their numbers-security will be enhanced. The shipments themselves may also be hardened when they have been aggregated and points of particular vulnerability can be identified and mitigated when routes are known and arrival and clearance times are available. Should an incident occur, fewer safe harbors will be needed to protect the relatively smaller number of targets.

Communications
Instead of monitoring 9,900 movements of individual rail casks, dedicated rail shipments will require the infrastructure to monitor between only 1,980 and 3,300 waste movements. The necessary communication within DOE, to the public and affected agencies will be drastically reduced.

Planning
Using dedicated trains makes it possible to more precisely predict the flow of SNF and HLW shipments through the national rail system-instead of a flood of separate individual rail cars throughout the rail system. The use of fewer trains will also make it possible to identify alternate suites of routes to enable waste to be rerouted in the event of changing rail operating conditions (for example rail system capacity issues in California) or rail industry operational issues (such as the Baltimore Tunnel fire). Dedicated trains may also make it possible to consider equity by shifting to other routes at different points in the program's history.

Although the consolidation of spent fuel assemblies into fewer casks will increase the routine radiological dose, those doses should be easier to manage because where the doses occur will be easier to predict. The use of dedicated trains makes it possible to identify areas where delays may occur and to mitigate routine exposures where necessary.

Programmatic
The DOE will experience programmatic benefits at least by leveraging its existing experience in shipping by dedicated rail. Benefits should also accrue by substantially reducing the number of shipments by combining the shipments into multiple rail car packages.

Public preference

As Ted Glickman pointed out in "For a Few Dollars More" technical explanations about the difficulty of using dedicated trains will be lost on a skeptical public [3]. The duration of the program ensures it will be a publicly visible program for many years, using dedicated trains enhances the perception of seriousness on the part of the DOE and the Federal Government.

The National Academy of Science report highlighted what it called the "social costs" of this program. The report argued that the non-radiological effects of the shipments may be as great as the radiological effects themselves. Using dedicated trains enhances the ability of DOE to present itself as a capable manager of these materials.

IMPLICATIONS OF DEDICATED RAIL

A glaring omission in the NAS report is the absence of discussion about rail route selection. Although there are no guidelines for rail route selection, the problem of how routes are chosen for the shipment of these materials may become extremely important in the coming years. A comparison of the national impact of alternative dedicated rail routing scenarios provides a starting point for rail routing discussion. This paper compares two alternative rail routing scenarios. The first is that proposed by the DOE as the "Mostly Rail" scenario in the Final Environmental Impact Statement for Yucca Mountain [4]. The other scenario is suggested by rail industry operating practices which may consolidate shipments at a number of gateways prior to shipment to Yucca Mountain. This routing scenario funnels SNF and HLW shipments through the Union Pacific gateways en route to Yucca Mountain.

This analysis compares two routing scenarios on the basis of which land use types of terrain are traversed by the scenario. Because of the historical development of the nation's rail lines, it can be expected that rail shipment of HLW will traverse relatively more urban areas than would truck shipments which may bypass urban areas. A previous analysis confirms that dedicated rail shipments traverse relatively more urban and suburban areas than truck shipment of waste [5].

Table I. Yucca Mountain Mostly Truck and Mostly Rail Route Miles, Compared by Land Use Type

	Mostly Truck Scenario Route Miles	Mostly Rail Scenario Route Miles
Central Business District	110	192
Suburban and Urban	3,634	4,281
Rural Miles	15,074	16,599

It is useful to note that there are no Federal (USDOT) routing regulations for Yucca Mountain shipments that require rail routes to avoid highly populated areas. Given the state of knowledge about the national rail network and the DOE program, it is possible to compare the impact of shipping SNF and HLW via dedicated train on the FEIS routes with the preferred routes suggested by the Union Pacific. Examining the impacts of the program at a national level is important and useful. The Western Governor's have requested this national-level appraisal [6].

The authors of this paper have previously examined the national impacts of alternative routing strategies for the truck mode [7]. A recommendation of the recent National Academy of Science Paper on the subject of SNF and HLW transportation was that the DOE begin the process of discussing routes with affected parties.

Land use and densities impacted by high-level radioactive waste

This analysis calculates the route miles that traverse three different levels of geography: central city, census place, and rural for each of the two scenarios. The central city, census place, and rural areas are significant, because of the different vulnerability of the different land uses that may be affected by an accident involving a release of radioactive material. The urban, suburban, and rural land use types are modeled in the RADTRAN risk analysis computer code [8]. The type of area affected is defined by the number of people living in a given area-the population density. The map in Fig. 1 depicts the areas of geography assessed in the paper. The population densities defined in RADTRAN are shown in Table II.

Table II. Land Use Population Densities Defined by DOE

Land Use Type	Population Density (per sq mi)
Urban	more than 3326
Suburban	139 to 3326
Rural	0 to 139

In order to examine the land use impacts of the alternate modes in a geographic information system (GIS), it was necessary to assign population densities to polygon features in a GIS. Geographic features with densities similar to the DOE land use types had to be used. For the urban land use, the Census Bureau's database of Central Business Districts (CBD) was used. This data is available from the Bureau of Transportation Statistics National Transportation Database. The geographic area most similar to the suburban land use is the database of Census Places. Unlike the Metropolitan Statistical Area, the Census Place area typically conforms more closely to both the terrain and the urban form in the locality. The third land use, rural, consists of what is left in the coterminous US.

The measurement of the shipping program's impact on the land use is the route mile. A route mile is the distance a SNF and HLW route traverses a particular land use type. The analysis assumes the more route miles traversing an area, the greater the impact on that area.

Forecasted Routes

The shipment program modeled was that described in the DOE FEIS, "mostly rail" scenario. The DOE proposed action, disposal of 70,000 metric tons uranium (MTU) at Yucca Mountain over 24 years, postulates 10,700 cask-shipments in the mostly rail scenario contained in the FEIS. There is a small truck shipping component for the mostly rail scenario that was not modeled.

In the consolidated scenario, SNF and HLW are routed to one of four "gateways." These gateways are: Chicago, St. Louis, Memphis, and New Orleans. From these four gateways, the waste then travels to Kansas City and then on to Yucca Mountain via Kansas, Colorado,

Wyoming and Utah. The consolidated scenario routes all shipments to Kansas City before sending them west to Yucca Mountain.

Fig. 2. Union Pacific Gateways and Kansas City

Method and Process

In order to compare rail routing scenarios, it was necessary to prepare both the spatial data for both the area and network geography. In order to prepare the area geography, it was necessary to remove the area features from inside the larger geographic areas to avoid double counting population or spatial extent.

In this analysis the urban core is extracted from within the census place area. The remaining census place area is then pulled from the remainder of the US. This leaves three sets of area layers: Urban cores (urban land use), Census Place (suburban land uses), and the remainder of the U.S. (rural). Once the areas were separated, an additional data field in each record of the table is added. The field contains the length-the distance traversing the area. This enables each area record to be tagged with the distance traveled by the shipping routes. This permits the lengths to be summed for each type of land use.

Modeling alternative routing scenarios required two different sets of routes. First, the FEIS network was identified using the DOE's Webtragis software. In order to analyze the network effects, routes were defined by running Webtragis for the origin and destination of each of the 77 sites. Once the routes were identified, the individual routes were aggregated so that a complete network of routes was created. After the network was available, shipments were assigned to the

links on the network and aggregated so that the number of shipments traversing a link would be summed for each link.

The result of the analysis is a network that shows the summed numbers of rail shipments that will traverse the network en route to Yucca Mountain. Once the networks have been constructed and the shipments assigned to the network, the networks are laid over the area geography. The results of the analysis identify the routes and the distance traversed by each type of land use.

In order to assess the impact of the consolidated routing scenario, the network was partitioned based on the location of the shipping sites, the network partitioning was then used to determine which minimum distance from each shipping site to a node representing each Union Pacific gateway. This analysis assumes that no waste will be shipped through Gibbon Junction in Nebraska or the Moffett tunnel west of Denver. Therefore waste would move north from Denver and then west to Yucca Mountain. This was done to assign each shipping site to a gateway location. Then a minimum distance was calculated between each shipping site and an appropriate gateway. A number of sites were not appropriate for gateway shipments. These shipments were routed directly to Yucca Mountain.

Fig. 3. Shipping sites partitioned by network

Of the total 77 sites, 31 sites were optimally routed through Chicago, 20 were not applicable for a UP gateway, 17 passed through Memphis, 8 directly through Kansas City, and 1 through St. Louis.

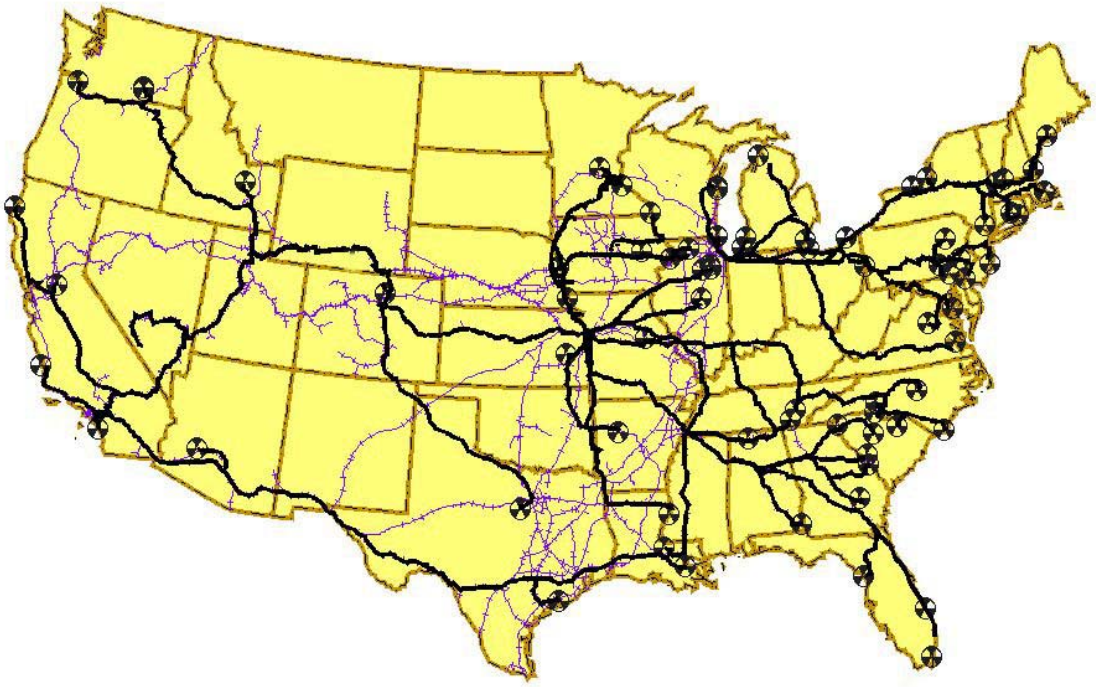

Fig. 4. Gateway routes to Yucca Mountain

Results

Once the networks are built and the shipments assigned to each network, they are then clipped by the area geography so that the length of each area contains both the numbers of shipments and the length of the route through the geographic layer. Then the distance traveled by each route through each type of land use can be summed. The results are in Table III.

Table III. Alternative routing scenarios compared by land use impact

	Mostly Truck Scenario Route Miles	Mostly Rail Scenario Route Miles	Consolidated Option Route Miles
Central Business District	110	192	199
Suburban and Urban	3,634	4,281	4,197
Rural Miles	15,074	16,599	16,341

The analysis confirms the expected result, that the shipment of high-level waste using dedicated train will have relatively greater impact on the urban areas than on rural. Additionally, the consolidated routing option slightly increases the impact on urban areas while decreasing it on suburban areas.

CONCLUSION

The use of dedicated trains for all rail shipments to Yucca Mountain would provide significant benefits to DOE and address the concerns of stakeholders. The 2005 DOE policy statement is a welcome movement towards use of dedicated trains for all rail shipments. The assumption that DOE will use dedicated trains is a prerequisite for meaningful rail route analysis.

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