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TRANSPORTATION CONSIDERATIONS IN SELECTING A NUCLEAR WASTE REPOSITORY

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Abstract

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The United States Department of Energy (DOE) has recommended three candidate sites for the first geological repository sites for commercial spent fuel and defense and commercial high-level waste. Transportation was an important factor in making the selection because it affects many performance objectives of a repository. In developing the detailed influencing factors for transportation and by providing the input which was used by DOE policymakers to select the sites, it became apparent that distance, the condition of the transportation infrastructure near the site, and site topography were important in influencing site selection.

Background

The Nuclear Waste Policy Act of 1982 (the Act) [1] charged the U.S. Department of Energy (DOE) with the responsibility for siting a mined geologic repository to dispose of commercial spent fuel and high-level waste. President Reagan subsequently made the decision that defense high-level waste be disposed of in the commercial waste repository as well. The Act mandated public involvement in all aspects of siting, beginning with public participation in developing repository siting guidelines.

The current waste management system is envisioned by DOE to include at least one repository, a transportation system, reactors and high-level waste sources, and an intermediate facility called a monitored retrievable storage facility (MRS). At the MRS, spent fuel would be consolidated, the disassembled rods would be placed in a canister, and the canisters would be temporarily stored. The MRS requires the authorization of the U.S. Congress. Site-specific work related to a second repository has been postponed indefinitely.

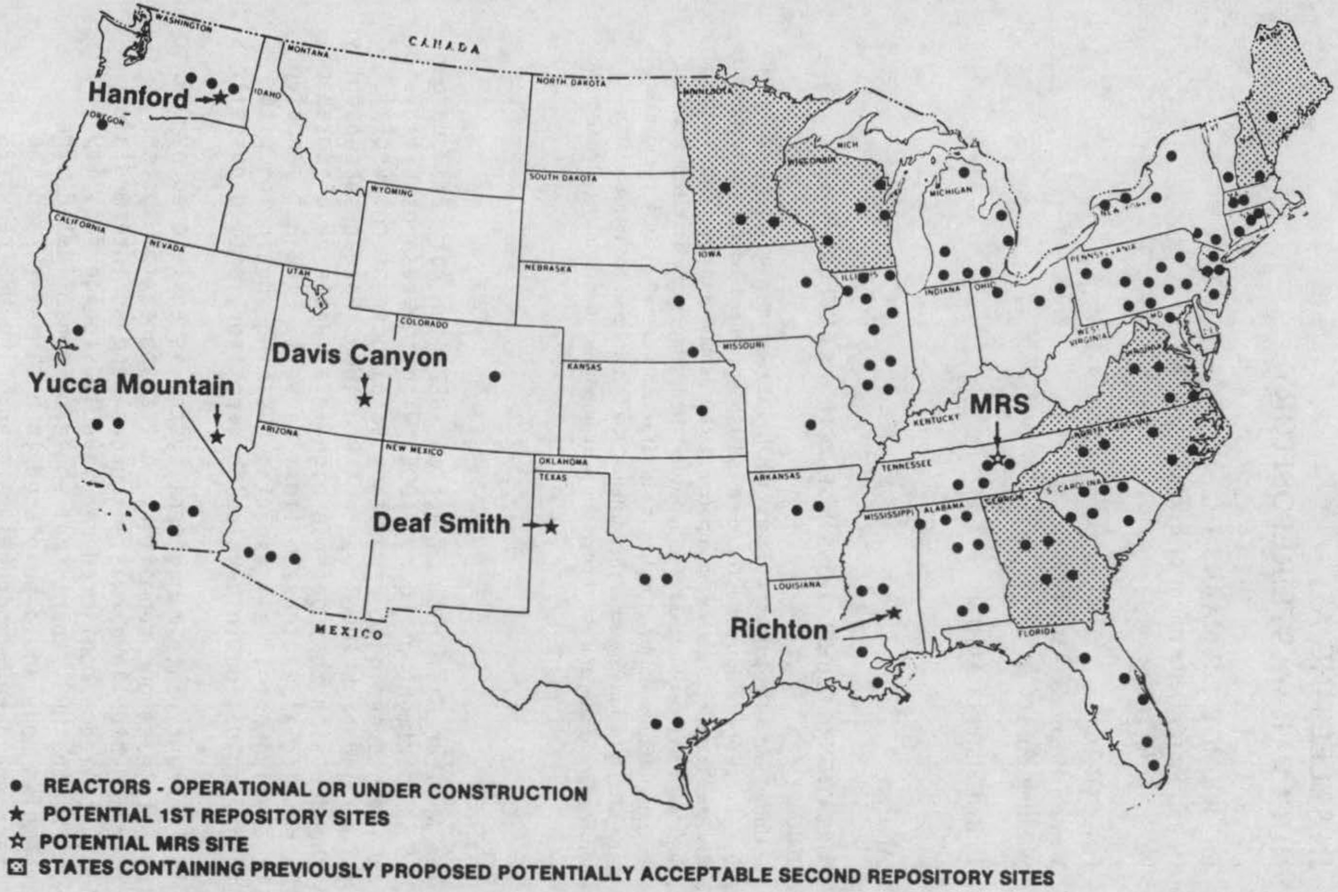

FIG. 1. Waste management facility locations.

Facility Locations

The locations of the reactors under construction or operating, the potential candidate sites for the first repository, the MRS and areas previously considered for the second repository are shown in Figure 1. Most of the spent fuel to be shipped is located in the eastern United States of America (USA), while the potential first repository sites are in the west. The candidate sites for the MRS are in the State of Tennessee, which is very near the geographic centroid for spent fuel. Most sites previously considered for a second repository are in the central or eastern USA, generally nearer to the sources of spent fuel than are the first repository sites.

General Method Used in Selecting Candidate Sites

The general method used in selecting candidate repository sites involves three distinct steps: (1) developing technical factors to be used in the decision; (2) developing "performance objectives" based upon these technical factors and compiling information and data according to the factors; and (3) applying values and preferences to select the sites. Technical factors were developed early in the siting process. Public comment was solicited and concurrence of the Nuclear Regulatory Commission was received. A final set of technical criteria were published as the "Final Siting Guidelines." (Title 10, Part 960 of the U.S. Code of Federal Regulations). Thirteen technical factors are identified for transportation.

The second step involved organizing these technical factors into performance objectives, which in turn allowed the use of decision-aiding methods. The major objectives were quite broad and intuitive. They were to: minimize adverse post-closure impacts of the repository and minimize adverse pre-closure impacts. These major objectives were then further subdivided into performance subobjectives, which relate to technical factors. Transportation performance subobjectives are included under the pre-closure impacts, where pre-closure is meant to include all activities that occur up to the time of sealing the repository. Major subobjectives within pre-closure are to minimize: (1) adverse impacts on pre-closure health and safety, (2) adverse environmental impacts, (3) adverse socioeconomic impacts, and (4) economic costs. Transportation-related activities influence each of these major subobjectives.

Also included in this second step is the compiling of the data and other relevant information related to the technical factors. The data are then reduced to a format consistent with

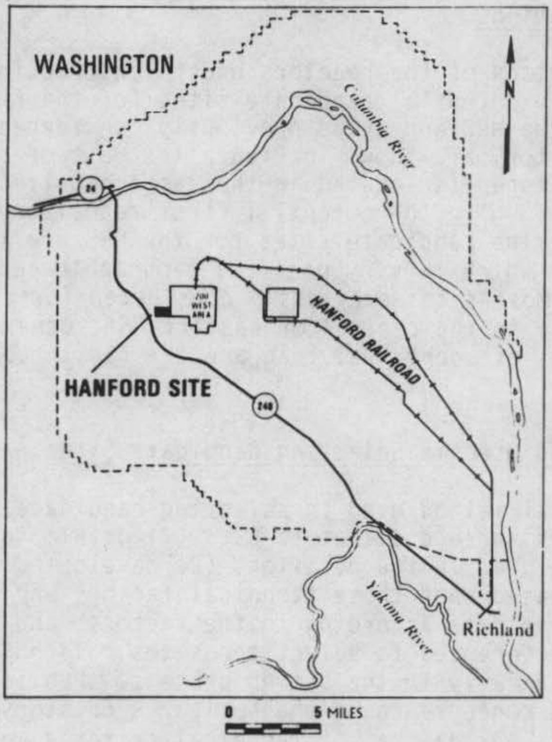

FIG. 2. Hanford site.

the terms needed to describe the performance objectives, e.g. dollars or statistical latent cancers.

The third step is where the data provided according to the performance objectives are evaluated. It was in this step that the values and preferences of DOE policymakers were introduced and a decision made about the top three sites that will be further characterized. The DOE recommended, and the President approved, sites at Yucca Mountain, Nevada; Deaf Smith, Texas; and Hanford, Washington for further study.

Site Descriptions

The general transportation infrastructure in the region around the sites is shown in Figures 2-6. The regional network is shown for both truck and rail. As shown in Figure 2, the Hanford site is quite near adequate existing truck and rail routes. The Yucca Mountain site and the Davis Canyon sites require extensive construction to provide access as shown in Figures 3 and 4. Moderate construction is required for Deaf Smith and Richton Dome, as can be seen in Figures 5 and 6.

FIG. 3. Yucca Mountain site.

FIG. 4. Davis Canyon site.

FIG. 5. Deaf Smith site.

Assumptions Used in Cost and Risk Analyses

The analyses were performed for a waste management system that includes the sources of spent fuel and high-level waste and a single repository. Because the MRS and second repository have not been approved by the U.S. Congress, they were not included. A total of 62,000 MTU of spent fuel and 11,825 MTU equivalent of defense high-level waste are shipped to the repository assuming that 70% of all the spent fuel and waste by weight is shipped by rail and 30% by truck.

The general approach used in the risk analyses was to use national average data except for values for population densities which were calculated using census tract data for the selected representative routes. Details of the risk and cost analyses are found in Reference [2].

FIG. 6. Richton Dome site.

Technical Assessment

The evaluation of and decision regarding candidate repository sites must include considerations of all the major objectives related to both post-closure and pre-closure. Information presented here may be considered as the basis for the evaluation and may have been reformatted during evaluation to ensure consistent measures for the performance objectives. The results given for risk and cost are considered to represent a most reasonable assessment of logistics. The results for the technical assessment are found in Table I.

Radiological Health Effects. Radiological health effects associated with transporting spent fuel and defense high-level waste to each of the potential candidate sites were calculated using established methods. Details are found in Reference [2].

Table I. Technical Assessment Data

	POTENTIAL CANDIDATE REPOSITORY SITES				
	Davis Canyon	Deaf Smith	Hanford	Richton Dome	Yucca Mountain
Radiological Health Effects[A]					
Transport Workers	.52	.46	.64	.37	.58
Public	2.5	2.1	3.1	1.7	2.9
Nonradiological Health Effects					
Transport Workers	2.1	1.6	2.7	1.3	2.5
Public	8.4	6.7	11.0	5.3	10.2
Site Characterization					
Rail Access Route, km	61-87	40-56	< 5	42	161
Length of Upgrade, km	0	0-21	0	0	
Proximity to Existing Route, km	48-58	0-21	77	0	0
Truck Access Route, km	40	2	< 5	6	26
Length of Highway Upgrade, km	103-109	6	0	37	0
Proximity to Existing Highway, km	103-278	22	0	35	0
Topography					
Tunnels	Required	Not Required	Not Required	Not Required	Not Required
Bridges	Required	Required	Not Required	Required	Required
Terrain	Very Rugged	Generally Flat	Generally Flat	Gently Rolling	Gently Sloping
Costs/$ million					
Rail Access Route	141-269	21-44	< 6[B]	16	151
Infrastructure Upgrade	0	10	0	0	0
Truck Access Route	79	1	< 6[B]	3	12
Infrastructure Upgrade	15-35	1	0	6	0
Operations	1240	1120	1450	970	1400

[A] Statistical latent cancers and first and second generation health effects.
[B] Truck and rail total.

The statistical latent cancer fatalities expected for each site (during the course of a 28-year shipment period) are given in Table I for transportation workers and the public. These values include expected impacts from radiological releases during accidents as well as from activities during normal operations.

The obvious conclusion drawn from comparing these results is that distance is the key factor influencing radiological health effects. However, other factors such as the population density along routes may result in some fluctuations to estimates of radiological health effects.

Nonradiological Health Effects. An analogous trend to that displayed for radiological health effects is manifest in the results for nonradiological health effects given in Table I. These effects are those expected from deaths due to traffic accidents; they are not attributable to the radiological nature of the cargo.

Environmental and Socioeconomic Impacts. Since the technical factors that result in impacts to the environment frequently affect socioeconomic considerations as well, a discussion of these performance objectives is combined. The results presented in Table I are not an exhaustive list of parameters used; however, they are believed to provide a representative characterization of each site.

The length of the access route to the sites from existing routes is an important factor in gauging the environmental disruption, while the length of existing roads that need upgrading may have more of an effect on the socioeconomic performance objective. The general topography of the area around the site will also determine how much environmental disruption will occur as well as the need for tunnels and bridges that result in additional environmental disruption. The controlling factors for socioeconomic and environmental performance objectives appear to be the topography and condition and extent of existing transportation infrastructure around the site.

It must be remembered that for the environmental and socioeconomic performance objectives, transportation is a contributing factor that may or may not be significant for the overall selection of a repository depending upon the magnitude of the impact resulting from the repository construction and operation.

Costs. The costs associated with transportation may be considered to be of two types: construction and operations.

The construction costs are those associated with the construction of new access routes to the repository site and upgrading existing routes that may be inadequate for the intended service. Operating costs are generated by activities related to fleet procurement and maintenance and the shipment of waste. Table I contains summary costs for each site. Where a range of values is given, several access routes may exist and could be chosen for waste transportation. Once again, key factors affecting transportation costs are terrain and distance, where distance here is both distance from adequate existing routes and the distance from the waste sources to repository sites.

Observations

A few observations can be made about the relative importance of some of the technical factors to the site selection process. Distance is the most important technical factor. Both the distance from the site to the waste sources and the distance from the site to the nearest route that does not require upgrading are influential in determining the actual performance measure (e.g. latent cancers, dollars, or displaced endangered species). The next most important factor is probably the topography of the area around the potential site. No one factor, however, was the sole determinant of which site was selected, and the performance measures must be viewed only as input to the final step in the site selection process.

REFERENCES

[1] The Nuclear Waste Policy Act of 1982, as signed by the President on January 7, 1983 (Public Law 97-425, 96 Stat. 2201, 42 U.S.C. 10101).

[2] CASHWELL, J. C., et al., "Transportation Impacts of the Commercial Radioactive Waste Management Program," SAND85-2715, Sandia National Laboratories, Albuquerque, NM (1986).