THE MONITORED RETRIEVABLE STORAGE (MRS) FACILITY AND ITS IMPACT ON SPENT FUEL TRANSPORTATION*

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ABSTRACT

The Department of Energy (DOE) has identified nine potential sites for a repository to permanently dispose of radioactive wastes. The DOE has also released information identifying expected transportation routes between nuclear reactors and these repository sites. More recently, the DOE has announced three potential sites for a Monitored Retrievable Storage (MRS) Facility in Tennessee. Obviously, if a large portion of the spent fuel should be routed to Tennessee for consolidation and repackaging, there will be significant changes in the projected routes and the number of shipments in the vicinity of the repository will be reduced. The MRS would also result in an increase in the number of spent fuel shipments through eastern Tennessee, while significantly reducing shipments through the central and western parts of the state.

INTRODUCTION

In response to the Nuclear Waste Policy Act of 1982, the Department of Energy has taken a number of steps toward establishing a permanent disposal facility for radioactive wastes. Nine separate candidate repository sites have been identified, a draft environmental assessment (EA) has been issued for each site, and the nine sites have been compared and ranked. The top three candidate sites, based on the draft EAs, are a basalt formation near Hanford, Washington; a tuff formation at Yucca Mountain, Nevada; and a bedded-salt formation in Deaf Smith County, Texas. A repository is scheduled to be constructed, presumably at one of the above sites, and to be in operation by 1998.

In the spring of 1985, the DOE announced three potential sites for an MRS facility that would be designed to receive spent fuel shipments from the commercial power reactors, consolidate the spent fuel, package it for disposal, and transport the consolidated fuel to the repository. Temporary storage would also be provided at the MRS. Current projections indicate that the MRS could start to receive fuel from commercial power reactors in 1996.

During the site-selection process, DOE investigated a number of potential MRS sites, primarily in the southeastern part of the United States. The three sites selected are located in the state of Tennessee. Two of the sites are only a few miles apart, near Oak Ridge. The preferred site is the abandoned Clinch River Breeder Reactor (CRBR) property, and an alternate is near the old Exxon nuclear fuel reprocessing plant site. The second alternate site is in central Tennessee, at the location of the cancelled Hartsville nuclear plant.

CHARACTERIZATION OF THE MRS SITES

The MRS sites are centrally located with respect to most of the commercial nuclear power plants. Thirty-three plants are within 500 miles of the potential MRS sites. These reactors are projected to supply ~45% of the spent fuel scheduled for transportation to the first repository.

Existing transportation facilities would also be favorable for the proposed MRS sites. For example, the Clinch River site is only seven miles from I-40, a major, east-west, Interstate highway. Rail service is available at two nearby DOE plants. A Southern Railway spur track is less than three miles west of the site, and a Seaboard System Railroad spur is located ~12 miles to the northeast. The Clinch River, which flows along to perimeter of the site, is navigable and is part of the Tennessee River system.

The Hartsville site, located northeast of Nashville, is ~120 miles west of the Oak Ridge sites, at a partially constructed, but abandoned, Tennessee Valley Authority nuclear plant. The Hartsville site is near two Interstate highways: I-40, 16 miles to the south; and I-65, 41 miles to the west. Rail service to the Hartsville site is not as convenient as at the Oak Ridge sites, since the nearest rail line terminates at Trousdale, Tennessee, 13 miles to the west. The spur line a Trousdale connects to the major Seaboard System Railroad's main line between Cincinnati, Ohio, and New Orleans, Louisiana.

Old Hickory Lake, which is part of the Cumberland River, is a navigable waterway that lies adjacent to the Hartsville site.

TRANSPORTATION SCENARIOS

Two transportation scenarios are described in this paper. The first scenario assumes that all spent fuel shipments are made directly from the reactors to the repository. Three candidate repository sites are considered: Hanford, Washington, Yucca Mountain, Nevada; and Deaf Smith County, Texas. The second transportation scenario assumes that reactors east of the

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Rocky Mountains make spent fuel shipments to an MRS facility. After repackaging, the consolidated fuel will eventually be shipped from the MRS to a repository. Reactors located west of the Rocky Mountains are assumed to make fuel shipments directly to the repository. In this scenario, the location of the MRS is assumed to be the preferred Clinch River site near Oak Ridge, Tennessee.

In each scenario, 62,000 metric tons of uranium (MTU) will be shipped and stored in a repository. However, the timing of the fuel shipments differs in the two scenarios. When all shipments are made directly to the repository, the first shipments will take place in 1998. By the year 2003, the repository will be operating at its designed level, and ~3,000 MTU of spent fuel will be transferred each year. The repository will contain the 62,000 MTU after 25 years of operation (in the year 2022).

In the MRS scenario, 62,000 MTU will also be shipped to a repository. However, the MRS should be ready to receive and consolidate fuel in 1996. By 1998, when the repository starts operation, the MRS will be receiving ~3000 MTU per year. Once the repository is ready, fuel shipments will be received from both the MRS and western reactors. The MRS is expected to continue receiving fuel through the year 2018 (a 23-year period), at which time all of the fuel from the eastern reactors destined for the first repository will have been shipped to the MRS. The repository will receive fuel shipments from both the western reactors and the MRS through the year 2022. The reader is referred to the DOE Mission Plan[1] for more details.

TRANSPORTATION PATTERNS

The next two sections discuss how the MRS facility will impact the expected transportation patterns. The projected number of fuel shipments from each reactor was calculated by McNair, et al.[2-4] The average number of shipments per year was calculated by dividing total shipments by the projected years of operation (25 if the shipment is being transported to a repository or 23 if the shipment is going to the MRS facility). Projected transportation routes were calculated using the HIGHWAY[5] and INTERLINE[6] routing models.

TRAFFIC PATTERNS AT A REPOSITORY SITE

Approximately 995 shipments by truck and 262 by rail would be required each year to transport 62,000 MTU of spent fuel directly to the repository from the reactors. A unique traffic pattern would be established for each candidate repository site. The estimated transportation routes for the Yucca Mountain site are shown in Fig. 1. In this figure, highway routes are shown as solid lines, while a dashed line is used to represent rail routes. The numbers along the route indicate the number of shipments expected each year.

For the Yucca Mountain site, highway shipments would approach the Las Vegas area from three directions. Approximately 58% of the shipments will be traveling along I-15 in southern Utah and northwestern Arizona. Interstate 40 through northern Arizona would be a second transportation corridor, carrying ~36% of the annual highway shipments. These shipments would probably leave I-40 at Winslow, Arizona, and travel along US the Las Vegas area. A small number of truck shipments (~6% of the total) originate in southern California and would follow the Interstate highway system in southern California. Between Las Vegas and the Yucca Mountain site, all shipments would travel via US-95.

Approximately 85% of the rail shipments to the Yucca Mountain site would be transported along the Union Pacific line between central Nebraska and southern Nevada. This is the rail line (in Fig. 1) which roughly parallels the highway routes in Utah. The remaining 15% of the shipments would transfer to the Union Pacific from other railroad companies in southern California.

When an MRS is included in the waste management scheme, the transportation patterns in the vicinity of the repository change significantly. At any of the repository sites, the annual number of truck shipments would be reduced from 995 to 201, an ~80% reduction. There would be a similar decrease in annual rail shipments, from 262 in the direct shipment scenario, to 30 shipments (from the western reactors) for the MRS scenario. The remaining fuel will be transported from the MRS in ~22 dedicated train shipments each year. This change can be seen by comparing Fig. 2, which shows the estimated transportation routes for the MRS scenario, with Fig. 1. The annual number of shipments for the two scenarios are summarized in Table I. It is immediately evident that an MRS would significantly reduce the number of shipments in Nevada and Utah.

Smaller traffic reductions with the MRS are identified in Table I for California and Arizona. In Arizona all truck traffic except that along I-15 between Utah and Nevada will be eliminated in the MRS scenario, since the eastern reactors would not ship fuel directly to the repository. This would remove ~360 shipments per year from I-40. The number of annual rail shipments in Arizona would be reduced from 28 to 16. These remaining shipments would be those originating at the Palo Verde reactor.

As shown in Table I, either scenario has the same transportation impact in the states of Idaho and Oregon. Shipments passing through these states would be those from reactors in Oregon and Washington. In either scenario, these shipments would be transported directly to the repository.

SPENT FUEL TRANSPORTATION PATTERNS IN TENNESSEE

Although the MRS would cause a net decrease in the number of shipments in the vicinity of the repository sites, the shipment of fuel from all eastern reactors to the MRS would cause a traffic increase in the vicinity of the MRS. However, this increase is not as drastic as one might expect. The spent fuel traffic through a number of eastern population centers would *actually* decrease. In order to illustrate these trends, detailed traffic patterns within the state of Tennessee are discussed in this section.

A significant number of spent fuel shipments is expected to pass through Tennessee in the various direct shipment scenarios. If a repository were located in Hanford, Washington, a

Table I. Transportation scenarios for transporting spent fuel to a candidate repository site at Yucca Mountain, Nevada

State	Shipments direct to repository		Shipments with MRS scenario	
	Rail	Truck	Rail	Truck
Arizona	28	933	16	139
California	42	62	30	62
Idaho	0	139	0	139
Nevada	262	995	52[a]	201
Oregon	0	139	0	139
Utah	220	573	22[a]	139

[a]Includes 22 dedicated trains between the MRS and repository.

Table II. Average annual number of truck shipments of spent nuclear fuel through Tennessee

Destination	Shipments through Tennessee[a]				
	Memphis	Nashville	Chattanooga	Knoxville	Total
Hanford, WA	47	270	180	0	317
Yucca Mtn., NV	360	313	180	43	360
Deaf Smith, TX	412	365	180	95	412
Oak Ridge, TN	0[b]	115[b]	172[b]	575[b]	862[b]

[a]All values are for direct shipment of spent fuel from reactors to repository sites, except the values given for Oak Ridge as destination.
[b]These values assume that ~53,000 MTU will be transported to an MRS located in Oak Ridge over a 23-year period. Dedicated trains transporting consolidated fuel from the MRS to a repository do not pass through any of the major cities in Tennessee.

Table III. Average annual number of rail shipments of spent nuclear fuel through Tennessee

Destination	Shipments through Tennessee[a]				
	Memphis	Nashville	Chattanooga	Knoxville	Total
Hanford, WA	25	3	3	7	61
Yucca Mtn., NV	3	12	22	7	61
Deaf Smith, TX	7	5	22	7	58
Oak Ridge, TN	24[b]	0[b]	54[b]	56[b]	269[b]

[a]All values are for direct shipment of spent fuel from reactors to repository sites, except the values given for Oak Ridge as destination.
[b]These values assume that ~53,000 MTU will be transported to an MRS located in Oak Ridge over a 23-year period. Dedicated trains transporting consolidated fuel from the MRS to a repository do not pass through any of the major cities in Tennessee.

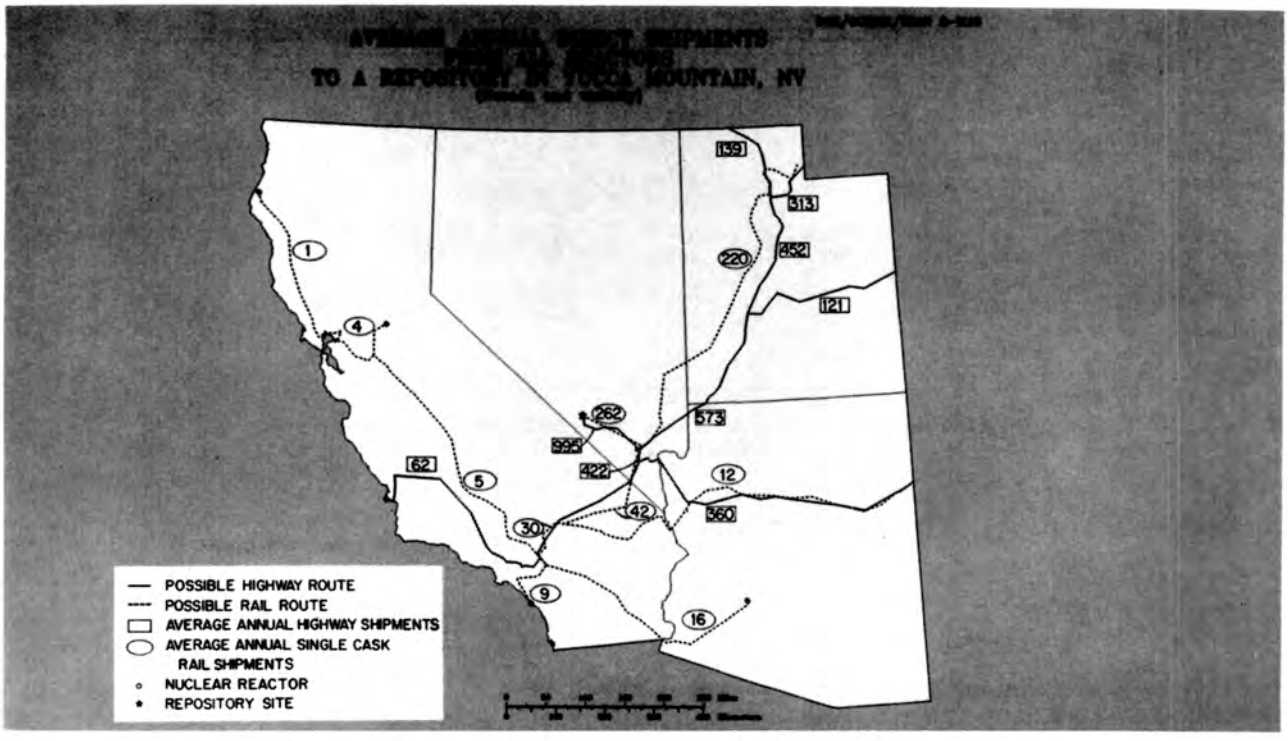

Fig. 1. Average annual direct shipments from all reactors to a repository in Yucca Mountain, NV.

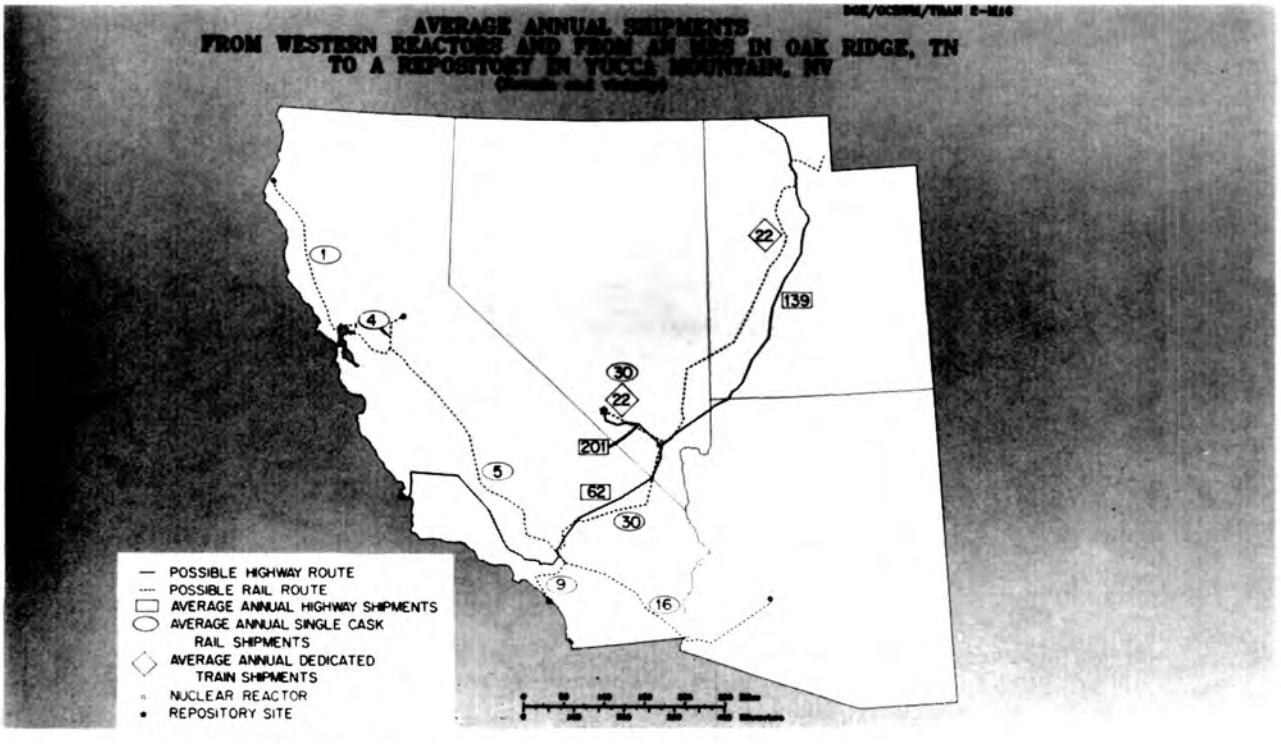

Fig. 2. Average annual shipments from western reactors and from an MRS in Oak Ridge, TN, to a repository in Yucca Mountain, NV.

southeast-to-northwest traffic pattern would be established. Shipments originating in Florida, Georgia, South Carolina, Alabama, and Mississippi would result in ~61 rail and ~317 truck shipments passing through Tennessee annually. For the other two repository sites, an east-to-west traffic pattern would be established. In addition to the shipments identified above, highway shipments would enter Tennessee from Virginia, and the total annual highway shipments would increase to 360 for a repository at Yucca Mountain and to 412 per year for a repository at Deaf Smith County, Texas. The number of rail shipments is essentially independent of repository location.

Highway and rail shipments that are expected to pass through the major Tennessee cities are summarized in Tables II and III, respectively. The Interstate highways passing through Tennessee cities are listed below:

1. Memphis: I-40 and I-55
2. Nashville: I-40, I-24, and I-65
3. Chattanooga: I-24 and I-75
4. Knoxville: I-40 and I-75.

It should be noted that any traffic flowing south along I-75 from Kentucky is considered to pass through Knoxville. However, any traffic flowing north along I-75 from Chattanooga to its junction with I-40 would not pass through Knoxville.

The trend in highway shipments through the major Tennessee cities reflects the general increase in east-west transportation when southwestern repository sites are being considered (see Table II). More shipments would move across the state when the repository site is located in Texas than when the site is in Washington. The rail shipments (see Table III) show a sizable variation with repository location. Memphis would experience the greatest transportation impact when the repository is located in Hanford, Washington. However, the maximum number of rail shipments would pass through Nashville if a repository were sited at Yucca Mountain and Chattanooga would experience more shipments for a repository site in Texas or Nevada.

The effects of an MRS are also shown in Tables II and III, since the line in each table labeled "Oak Ridge" shows the number of shipments expected to pass through the major Tennessee cities in the MRS transportation scenario, where it was assumed that ~53,000 MTU of spent fuel will be transferred from the eastern reactors to the Oak Ridge site over a 23-year period. While the total number of highway shipments would increase to 862 annually, the number of shipments passing through Memphis, Nashville, and Chattanooga would decrease. In fact, no highway shipments are expected to pass through the Memphis area with the MRS scenario. The number of shipments passing through Knoxville will increase as a result of fuel shipments originating at the reactors in the northeastern part of the country.

The number of annual rail shipments through Tennessee will increase from ~60 to ~270 for the MRS scenario. In the Memphis area, 24 rail shipments would be expected each year. These shipments would be fuel transported from the reactors located in Nebraska, Kansas, Arkansas, and Texas, eastward to the MRS. The number of rail shipments passing through Memphis to the MRS would be approximately the same as the number of shipments through Memphis if all fuel were shipped directly to Hanford, Washington (see Table III). In the MRS scenario, no rail shipments are expected to pass through Nashville. The majority of rail shipments from the upper midwest would pass directly from Kentucky to the MRS site without going through either Nashville or Knoxville. An MRS would result in an increase in the number of rail shipments passing through Chattanooga and Knoxville every year, 54 and 56 annual shipments, respectively. However, even at these increased rates, only one shipment would pass through each of these areas per week.

The dedicated trains transporting consolidated fuel from the MRS to the repository are expected to travel directly north into Kentucky and would not pass through any of the major Tennessee cities.

While the MRS would increase the number of shipments within the state, it has been shown that, in general, the number of shipments in the western part of the state wouldactually decrease. The only sections of the state showing an increase in number of shipments is the northeastern portion, and particularly the vicinity of Oak Ridge. Even with this increase, the number of truck shipments is expected to be two to three per day. About five rail shipments are expected to arrive at the MRS each week.

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