ANALYSES OF POTENTIAL EFFECTS OF AN MRS FACILITY ON SPENT FUEL TRANSPORTATION REQUIREMENTS

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ABSTRACT

The Department of Energy is currently evaluating the need for and feasibility of a Monitored Retrievable Storage facility (MRS) as an integral part of the nuclear waste management system. The results of this investigation, with accompanying recommendations, will be provided to the Congress of the United States for their consideration. As part of the evaluation of the integral MRS facility an assessment of the impacts to the waste management system are being studied. This paper presents the results obtained from analyzing the potential impacts of an integral MRS facility on the transportation portion of the waste management system.

INTRODUCTION

A series of analyses has been performed by Pacific Northwest Laboratory (PNL) to determine the potential impact of a Monitored Retrievable Storage Facility (MRS) on the overall Waste Management System Transportation Requirements. These analyses have investigated the interactions of the MRS facility with the waste management system. The analyses were performed utilizing a generic transportation/siting program entitled TRANSIT. This program was developed by PNL under the direction of the Transportation Technology Center (TTC) as part of an overall facility siting strategy. Transit was used to derive equipotential lines of transportation cost, risk and cask-miles for various areas of the U.S.

BASIS

The basis for this study was derived from the investigation of three transportation scenarios. In all cases 70,000 MTU of spent fuel was transported to a single repository. The three cases investigated included:

1. Shipping all spent fuel from individual reactor sites by truck for comparison with repository EA analysis (1 PWR or 2 BWR assemblies per cask)

2. Shipping all spent fuel from individual reactor sites by rail (7 PWR or 18 BWR assemblies per cask)

3. Shipping by rail cask from reactors with rail capability and truck cask from the remaining reactors.

The base case required the shipment of all 70,000 MTU of spent fuel directly to one of three candidate repository sites (Hanford, Yucca Mountain, or Deaf Smith). The impact of an MRS Facility on three basic parameters (risk, cost and cask-miles) was then determined by shipping the spent fuel through an MRS facility and then to each of the three repository sites. The use of TRANSIT allowed the parametric variation of MRS locations across the U.S. The MRS facility was assumed to have the capacity to consolidate the spent fuel before shipping to the repository. The shipments from the MRS to the repository were assumed to be made entirely by rail in single car shipments by general-freight mode. The capacity of the MRS to repository rail cask was adjusted from a minimum capacity of 7 PWR or 18 BWR assemblies per cask to a maximum of 25 PWR or 63 BWR assemblies per cask (cask capacity factor = 3.5). The minimum capacity factor required for the MRS to repository rail cask to achieve less than or equivalent cost, risk or cask-miles with the corresponding "direct to repository" case was then determined. The capacity factor is defined as the degree of compaction that is required to achieve a given cask capacity (i.e., a capacity factor of two would result in a MRS to repository cask capacity of 14 PWR or 36 BWR assemblies per cask). The resultant capacity factors for the various parameters investigated are shown in TABLE 1.

RESULTS

The results of this study are listed for both the base cases and the cases involving an MRS facility. The results are shown as the average number of cask-miles, the average cost (includes shipping, security and cask lease) and the average predicted fatalities per shipment for individual shipments of spent fuel from reactor sites. The cases involving the shipment of spent fuel to an MRS, subsequent consolidation, and then shipment to each of three repository locations shows the MRS to repository cask capacity factor required to achieve less than or equivalent parameters when compared to the "direct-to-repository" case.

The results show a very similar trend between cask-miles and transport risk for both the 100 percent truck shipment cases and the reactor preference (shipments by rail, if available, and truck when not) cases. This is primarily due to the majority of cask-miles and transport risk being attributable to the large number of truck shipments required in each of these cases. The introduction of an MRS facility allows the reduction of a large number of truck cask-miles into a much smaller number of rail cask-miles. This allows a direct reduction in total cask-miles within the system. The total transportation risk incurred by shipping spent fuel through the MRS shows a very similar reduction. The results for each of the parameters investigated are discussed in the following sections.

CASK-MILES

The introduction of an MRS facility allows a minimum reduction of approximately seven truck cask-miles into a single rail cask-mile. *This reduction* is achieved by assuming shipments from the MRS to the repository will be made by rail only. This reduces the overall cask-miles for truck shipments substantially and therefore the overall cask-miles for the system. In both the 100 percent truck and reactor preference

TABLE 1

Repository Location	Direct to Repository			Through Intermediate Facility					
				100% Truck[a]		100% Rail[b]		Reac Pref[c]	
	100% Truck[a]	100% Rail[b]	Reac Pref[c]	CF	Value	CF	Value	CF	Value
A. Cask-Miles[1]									
Hanford	2,100	2,450	2,300	1.0	985	1.5	2,275	1.0	1,630
Yucca Mountain	2,000	2,300	2,150	1.0	960	1.5	2,150	1.0	1,575
Deaf Smith	1,350	1,550	1,500	1.0	840	1.5	1,520	1.0	1,250
B. Cost[2]									
Hanford	20,000	132,000	47,000	1.5	19,625	2.5	122,780	2.0	46,250
Yucca Mountain	18,700	123,400	45,000	2.0	16,600	2.5	121,700	2.5	41,500
Deaf Smith	13,500	103,300	36,000	2.5	13,425	3.5	99,950	3.0	35,500
C. Risk[3]									
Hanford	425	830	525	1.0	235	2.5	836	1.0	440
Yucca Mountain	385	760	475	1.0	230	2.5	776	1.0	420
Deaf Smith	260	515	350	1.0	185	2.0	532	1.0	312

1 Cask-miles shown in cask-miles per shipment from reactor
2 Cost shown in dollars per shipment from reactor
3 Risk shown in total fatalities per shipment from reactor times 10^6

a 174,500 total shipments from reactors
b 22,640 total shipments from reactors
c 65,490 total shipments from reactors

shipping cases the overwhelming majority of cask-miles to transport spent fuel directly to the repository are attributable directly to truck shipments. The introduction of the MRS facility allows for the reduction in system total cask-miles by replacing a large percentage of truck cask-miles with a substantially smaller number of rail cask miles.

For the 100 percent rail case, a compaction factor of 1.5 is required at the MRS facility to show a system's reduction in total cask-miles. A compaction factor is now required as the system can no longer take advantage of the cask-mile savings achieved by trading truck cask-miles with rail cask-miles. A compaction factor higher than 1.5 will further reduce the total system cask-miles.

COST

The total cost (shipping/security/lease) for shipping spent fuel by either truck or rail is roughly equivalent on a "per assembly" basis. A direct reduction of the total system cost is therefore harder to achieve than a reduction in total system cask-miles as described previously. The introduction of a capacity factor between 1.5 and 3.5 is required to show an overall systems savings for cost. As in previously described cases, further increases in the capacity factor will continue to lower the cost for transporting the spent fuel.

RISK

The risk calculations utilized a single set of weighted unit risk factors describing the total anticipated fatalities per mile (occupational and non-occupational over all population zones) for both radiological and non-radiological risk for both truck and rail transport of spent fuel. These unit risk factors were derived from the factors and population distributions presented in the latest cost/risk report (Sand 84-1795, TTC-0506). Utilizing these risk factors results in the total risk of transporting spent fuel by rail to be slightly higher than transporting by truck on a per mile basis. The overall reduction in system risk is therefore achievable in the same manner as was done for cask-miles. The introduction of an MRS facility allows the opportunity for a substantial reduction in the total amount of truck miles and replaces them with a smaller amount of rail miles. This trading of modal miles results in an overall reduction in systems transportation risk.

In the 100 percent rail case, a linear relationship was assumed between total risk per mile and capacity factor. If the MRS facility performed compaction operations that allowed the outgoing rail cask to contain twice the capacity of the incoming rail cask, then the unit risk factor was also assumed to double. This assumption is overly conservative as it does not properly account for self shielding effects that will reduce the overall radiological dose rates. In all cases investigated, the use of this assumption led to the general flattening of the anticipated risk with capacity factor results. An MRS facility was found not to have an appreciable effect on the overall anticipated transport risk to the system utilizing the above assumption. The incorporation of self-shielding into the analysis would provide system reduction in transport risk for the 100% rail case.

SUMMARY

The addition of an integral MRS into the waste management system shows the potential for reducing the total number of miles and the associated transport risk from the reference system. This reduction appears to be possible at an equivalent transportation cost to the reference system. The final design of the MRS-to-repository cask has not been made, but it is believed that the capacity of this cask could be designed within the limits specified by the capacity factors listed in this report.