ECONOMIC IMPLICATIONS OF MRS ON THE WASTE MANAGEMENT SYSTEM

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SUMMARY

This paper presents an analysis of the impact of the use of monitored retrievable storage (MRS) of spent fuel on the cost of the spent fuel management system when MRS is used (i) for surge storage in the event of delay in repository deployment and (ii) as an integral part of the repository system. It was found that the use of MRS need not add significantly to the cost of disposal and may be made to be even more economical than disposal without the use of MRS.

The Nuclear Waste Policy Act of 1982 (NWPA), among other things, provided that both the Executive Branch of the Government and the Congress proceed expeditiously to fully consider a proposal for the construction of one or more Monitored Retrievable Storage (MRS) facilities for the long term storage of spent nuclear fuel and high-level waste (HLW). The NWPA recognized that such long term storage represents an option for providing safe and reliable management of such materials, and directed the DOE to complete, by June 1, 1985, a detailed study of the need for and feasibility of constructing MRS facilities.

The use of MRS for the long term storage of spent fuel and HLW is not a new concept. It was first considered in connection with the management of HLW in the design of the Retrievable Surface Storage Facility (RSSF) in the early 1970's, and in the design of the Storage of Unreprocessed Fuel Facility (SURFF) in the middle 1970's. Long term storage of spent fuel and HLW has been adopted by Sweden as part of its national strategy for waste management.

In the United States, the opponents of the nuclear option use such long term storage as prima facie evidence of the fact that no ultimate method of disposal exists for spent fuel or HLW, and to cast doubts in the public's mind that a safe and environmentally acceptable method of ultimate disposal ever can or will be developed. From my observations on the matter, the industry is not particularly in favor of the use of MRS as it feels that the resources that would have to be devoted to deployment of MRS facilities would be better spent in assuring the timely development and deployment of a repository system. Further, I believe that both the DOE and industry are concerned about the impact that the use of MRS would have on the confidence of both the public and the Congress in the ability of DOE to successfully develop and deploy repositories for ultimate disposal of spent fuel and/or waste. Nevertheless, the DOE has diligently pursued the requirements and intent of the NWPA; it has been in the process of selecting the preferred methods of MRS storage and has contracted for the services of an architect engineering consortium to provide an advanced conceptual design of the principal site-specific concept for MRS and the conceptual design of four alternative site-specific design concepts.

The use of MRS for spent fuel and/or HLW storage can be considered in two basic ways:

(1) As a means of providing surge storage in the event of a delay in repository deployment (i.e., not all of the spent fuel and/or HLW would be stored in MRS--only that necessary to meet the DOE's commitment to utility companies under their disposal contracts)

(2) As an integral part of the disposal system (i.e., where all spent fuel and/or HLW

would be stored in MRS for a period of 25-50 years to allow the major portion of the heat emitters to decay, followed by emplacement in repositories).

The DOE has been directing its emphasis on the prospective use of MRS for surge storage in the event of repository delays. However, the use of MRS to provide long-term cooling of spent fuel and/or HLW has a number of prospective benefits. The lower heat output of these materials which would result from long-term cooling reduces both the near field and far field heat effects on the repository host rock, it makes possible the closer spacing of waste packages in the repository, and it permits greater package loadings. All of these factors should not only contribute to a reduction in the cost of construction and operation of the repository system, but should also reduce the uncertainties that prevail with respect to the impact of decay heat on the performance of the host rock as an isolation barrier. The latter also represents an economic advantage inasmuch as the existence of such uncertainities means that repository design must be highly conservative in order to compensate for the prevailing uncertainties, thus increasing both repository costs as well as costs for research and development.

One of the concerns that has been expressed (other than that of adverse public reaction) regarding the prospective use of MRS for any purpose is that the inclusion of a MRS facility in the waste management system would result in higher costs for waste disposal than contemplated by the NWPA. E. R. Johnson Associates, Inc (JAI) has been conducting a series of internally supported studies to examine this prospective problem. It is the purpose of this paper to present the results of some preliminary studies which we have conducted on this matter.

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Two basic studies have been conducted by JAI, one to determine the cost of including MRS facilities in the disposal system as surge capacity in the event of repository delay, and one to determine the cost of including them as an integral part of the disposal system. In both studies, the cost of the use of MRS facilities in a waste disposal system was compared to that of a system that involved no MRS facilities (Base Case).

In all individual cases examined in both studies, it was assumed that the disposal system included the deployment of a total of three repositories , each having a capacity for emplacement of a total of 72,000 MTU, at a rate of 1,800 MTU/year for the first five years of operation and subsequently at a rate of 3,000 MTU/year for a period of 21 years. The capital cost of each repository was assumed to be $1.8-billion and was spent over a period of seven years prior to the year of startup. The annual repository operating cost was assumed to be $140-million. The cost of decommissioning of each repository was assumed to be $340-million and was spent over a period of six years after the repository had been filled to capacity. These were basically the same cost figures used in the development of the report entitled, "Report of Financing the Disposal of Commercial Spent Nuclear Fuel and Processed High Level Radioactive Waste", DOE/S-0020, dated June 1983, adjusted for escalation to 1983.

The cost of transporting spent fuel from the reactors or to either the MRS facilities or the repositories was assumed to be $29/kgU, the same value as was used in DOE/S-0020 and adjusted for escalation. In the MRS cases, however, it was assumed that an additional $15/kgU cost would be experienced in transporting the spent fuel from the MRS facility to the repositories.

In the Base Case, the same pattern of research and development expenditures was used as was contained in DOE/S-0020, except that additional expenditures were assumed because DOE/S-0020 employed only two repositories, while this study involved three repositories whose operations covered a longer time period. In the MRS cases, a pattern of research and development costs was used which followed the basic pattern set forth in DOE/S-0020, but provided for reduced expenditures for years in which the schedule was stretched out.

COST OF SPENT FUEL DISPOSAL USING MRS FOR SURGE STORAGE

The estimated 1983 cost of the use of MRS for surge storage of spent fuel in a repository system was developed for two cases of MRS usage; one in which the first repository was delayed 5 years and one in which it was delayed 10 years, requiring MRS facilities having total storage capacities of 30,000 MTU and 72,000 MTU, respectively, and annual receiving capacities of 3,000 MTU. The MRS facilities were assumed to consist of receiving, disassembly, canning, transfer and field drywell storage facilities. The following table sets forth the cost assumptions used:

TABLE I

ASSUMED COSTS OF CONSTRUCTION AND OPERATION OF MRS FACILITIES

	Total Storage Capacity	
	30,000 MTU	72,000 MTU
Capital Cost	$220 X 10^6	$240 X 10^6
Cost of Individual Drywell and Canisters	23 X 10^3	23 X 10^3
Annual Operating Cost (loading & unloading)	30 X 10^6	30 X 10^6
Annual Operating Cost (storage only)	5 X 10^6	6 X 10^6
Decommissioning Cost	104 X 10^6	216 X 10^6

Lifetime system costs were determined for each of the surge storage cases studied and such costs were discounted to 1983 at a discount rate of 2 percent/year, the same discount rate used in DOE/S-0020. Unit costs for MRS and disposal were determined for each of the cases studied. The following table sets forth a comparison of the unit costs for the two cases studied as well as for the Base Case, and a breakdown of the components thereof.

TABLE II

ESTIMATED UNIT COSTS FOR MRS AND DISPOSAL WHERE MRS IS USED FOR SURGE STORAGE

(1983 Dollars)

	Unit Cost for Indicated Case ($/kgU)		
Cost Component	Base Case (No MRS)	30,000 MTU (5-Year Repository Delay)	72,000 MTU (10-Year Repository Delay)
MRS System Costs	-	$ 9	$ 16
Repository System Costs	$ 72	66	61
Transportation	23	25	26
Research & Development	37	37	40
Total	$132	$137	$143

From the preceding table, it can be seen that the use of MRS to provide surge storage for a repository system to support a 5-year delay in repository deployment results in an increase in cost of about $5/kgU (4 percent) over that of a repository system without an MRS facility, and the use of an MRS to support a 10-year delay in repository deployment results in an increase in cost of about $11/kgU (8 percent) over that of a repository system without an MRS facility.

COST OF SPENT FUEL DISPOSAL USING MRS AS AN INTEGRAL PART OF DISPOSAL SYSTEM

The estimated 1983 cost of the use of MRS as an integral part of a spent fuel disposal system was developed for three cases of repository cost assuming that spent fuel would be stored for 50 years in MRS prior to emplacement in a repository; one where no cost reduction for the repository system was realized through the use of MRS, one where a 10 percent cost reduction in construction and operation of the repository system resulted from the use of MRS, and one where a 20 percent cost reduction in construction and operation of the repository system resulted therefrom. In each of these cases three MRS facilities each having total storage capacities of 72,000 MTU and annual receiving capacities of 3000 MTU were deployed.

The same costs were used for construction and operation of MRS facilities having a total capacity of 72,000 MTU as were set forth in Table I. Lifetime system costs were determined for each of the cases of integral use of MRS which were considered and such costs were discounted to 1983 at a discount rate of 2 percent/year, as in the surge storage study. Unit costs for MRS and disposal were then determined for each of the cases studied. The following table sets forth a comparison of the unit costs for the three cases considered as well as for the Base Case, along with a breakdown of the components thereof.

TABLE III

ESTIMATED UNIT COSTS FOR MRS AND DISPOSAL WHERE MRS IS USED AS AN INTEGRAL PART OF THE DISPOSAL SYSTEM

(1983 Dollars)

	Unit Cost for Indicated Case ($/kgU)			
		MRS Cases		
Cost Component	Base Case (No MRS)	Case 1 No Repository Savings	Case 2 Repository Costs 10% Less Than Base	Case 3 Repository Costs 20% Less Than Base
MRS System Costs	-	$ 38	$ 38	$ 38
Repository System Costs	$ 72	25	22	20
Transportation	23	28	28	28
Research and Development	37	41	41	41
Total	$132	$132	$129	$127

From the preceding table, it can be seen that the use of MRS as an integral part of the disposal system to provide storage for a period of 50 years prior to emplacement of spent fuel in a repository system costs no more than direct disposal thereof in a repository system without MRS. However, these unit costs could be reduced by 2-4 percent if the use of MRS resulted in a decrease of 10-20 percent in the cost of construction and operation of the repository facilities.

OPTIMIZATION OF COSTS

The unit costs for the MRS cases set forth in Tables II and III are far from being optimized; there are a number of economies that might be achieved in order to make the use of MRS comparable (or even less costly) than operation of a repository without MRS support. Some optimizing possibilities are described by the following:

(1) If metal storage casks which are capable of being transported were used by utility companies for supplemental at-reactor storage, these could be shipped to the MRS, stored there, and later be shipped to the repository. While the total capacity provided by these casks may not be sufficient to handle all the spent fuel subject to MRS storage, the cost of MRS storage modules would be reduced through the use of the cask for storage, and the cost of transport would be reduced by about 70 percent for the shipment between the MRS facility and the repository for that fraction of the spent fuel which is stored in the MRS facility in casks received from the utility.

(2) Reductions in the capital costs for MRS facilities may be achievable (compared to those used in this study), by as much as 25-50 percent. Moreover, this study used a cost of $23,000 for a drywell installation which was designed for placement in Eastern U.S. locations. Location of a MRS facility in an arid region could be expected to result in a reduction in this cost by 50-75 percent.

(3) Careful planning and scheduling of research and development programs and projections of expenditures therefor could result in a pacing of research and development expenditures during periods of delay in repository deployment, which could result in a reduction in such expenditures over those assumed for this study.

(4) Disassembly of spent fuel and encapsulation thereof for MRS purposes in a configuration which could be directly inserted into the waste package for disposal would result in a significant reduction in operating costs at the repository. Moreover, the capital costs of the waste packaging facility at the repository could be significantly reduced in cases where individual repositories received such disassembled and configured spent fuel from MRS facilities.

(5) The collocation of MRS facilities at the site of a repository would result in lower costs for transportation through elimination of the need to ship the fuel twice. Moreover, such collocation would permit the design of waste packaging facilities so that they could be used for receipt, disassembly and packaging of spent fuel for MRS purposes as well as packaging for disposal -- at virtually no increase in capital cost.

It is recognized that the NWPA does not permit the collocation of MRS and repository facilities in the same state. This is an absurd restriction which has no real technical or economic basis. It was included in the NWPA solely for political purposes and to prevent DOE from ever being prejudiced in favor of a site for a repository on the grounds that a MRS facility was already located there. However, the occurrence of the latter seems highly unlikely inasmuch as the Congress has reserved for itself the rights of approval of program activities and authorization of funding -- and has reserved for the states and tribal councils the rights of concurrence with the siting of both MRS and repository facilities. What the restriction really accomplishes is to prevent the DOE from making good management judgements in optimizing the design and operation of the waste management system.

In addition to the foregoing, there are a number of other possibilities for optimization of the MRS-Repository system.

In summary, it appears that the use of MRS for either surge storage of spent fuel in the event of delays in deployment of a repository system or as an integral part thereof need not add significantly to the cost of disposal -- and may be made to be even more economical than disposal without the use of MRS.