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MRS [Monitored Retrievable Storage]

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File: MRS

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NED McWHERTER
Governor

JIM HALL
Executive Director

July 21, 1989

The Honorable Albert Gore, Jr.
United States Senate
393 Russell Senate
 Office Building
Washington, DC 20510

Dear Senator Gore:

I want you to know about Governor McWherter's recent communication to the Monitored Retrievable Storage Review Commission. His enclosed letter commends the MRS Commission for their public hearing and fact finding activities, but also challenges the Commission to make a decisive recommendation on MRS. The enclosed comment paper, submitted to the Commission with the Governor's letter, documents that new research results, the trends in technological and institutional developments, and the strong policy position taken by the Tennessee Valley Authority all indicate that the MRS should be rejected by the Commission.

The MRS Commission has a chance to help put the nation's nuclear waste program back on track. By soundly rejecting MRS, "with finality" as Governor McWherter's letter states, the Department of Energy could regain a needed focus on the permanent isolation of nuclear waste in a deep geologic repository.

The MRS Commission is scheduled to submit its recommendations to Congress on November 1. We look forward to working with your office at that time in responding to their report to Congress.

I am also enclosing recent research results from studies conducted for the State Planning Office by the University of Tennessee. These serve as support documents for the state's final comments to the MRS Commission.

Sincerely,

Jim Hall

Jim Hall
Executive Assistant
to the Governor

State of Tennessee

NED McWHERTER
GOVERNOR

July 20, 1989

Commissioner Alex Radin
Commissioner Frank L. Parker
Commissioner Dale E. Klein
Monitored Retrievable Storage
 Review Commission
1850 M Street, NW
Suite 1030
Washington, DC 20036

Dear Sirs:

Commissioners and staff of the MRS Commission will be meeting soon to develop final recommendations which will be presented to the Congress. You and your staff have done a very commendable job of hearing the many views from across the nation concerning the U.S. Department of Energy proposal for monitored retrievable storage. Your consultants will soon be providing to you yet another layer of technical input on the issue.

In the final analysis you must decide if the considerable MRS cost and associated burden to utility ratepayers can be justified by claims of rather subjective system efficiency and public policy benefits.

We have continued in our efforts to answer this question as, I believe, the MRS Commission has. The Tennessee evaluation team of state officials and university researchers has stayed at work on this issue. In the Tennessee Valley some $100 to $200 million hangs in the balance, and the ratepayers in our state want to know that they will be treated fairly.

We have followed the changes in the nuclear waste program since the 1987 Nuclear Waste Policy Amendments Act. The technical developments in the nuclear waste field have been monitored. We have followed (and participated in) the extensive activities associated with the MRS Commission's analysis of the DOE proposal.

Our firm conclusion is that the monitored retrievable storage concept should be, once again, rejected. It should be rejected this time with a finality that will allow DOE to regain a proper focus in the nuclear waste program; a focus on the permanent isolation of nuclear waste in a deep geologic repository.

State of Tennessee

NED McWHERTER
GOVERNOR

The strong direction of technical and institution developments since 1985, when MRS was again proposed by DOE, has been away from justification of this concept. The "Tennessee Final Comments" to the MRS Commission" and the reference research reports, which are being mailed to you under separate cover, support that conclusion.

Your efforts to conduct the fact-finding portion of your work in a fair and systematic matter have been noticed and appreciated. You now have a chance to place the nation's nuclear waste program back on a sound foundation. We look forward to your recommendations.

Sincerely,

Ned McWherter

Ned McWherter

NM/BLS:km

Enclosures (4)

"Tennessee's Position on the MRS: Final Comments to the Monitored Retrievable Storage Review Commission

by the

State of Tennessee
July, 1989

Since April, 1985 the State of Tennessee has carefully reviewed three Department of Energy proposals and the documents upon which they were based. The State also conducted an independent review of the need and feasibility of an MRS. The state agencies also examined the impacts of such a facility on the health, safety and economy of the state.

The State has carefully reviewed the testimony presented to the MRS Review Commission, the January 17, 1989 MRS position statement of the Tennessee Valley Authority, the publicly-available studies on the MRS conducted by various parties including the Department of Energy, and two recent studies conducted by the University of Tennessee for the State. This written statement represents the State's final comments on the MRS for consideration by the MRS Review Commission.

Summary

1. The State of Tennessee stands by and advocates its original position that the MRS is not needed, that it is too expensive, and that a better solution -- the Integrated No-MRS system -- exists for managing the nation's spent nuclear fuel and high level nuclear waste.

2. The Tennessee Valley Authority position on MRS (January 17, 1989 statement to the MRS Commission) and two recent studies conducted by the University of Tennessee validate the State's position and document that:

a) the Integrated No-MRS system is technically feasible, cost-effective, and has many advantages;

b) the MRS is significantly more expensive that the Integrated No-MRS system; and

C) the Integrated No-MRS system is by far the most preferred system taking into account all public policy issues including technical feasibility, institutional feasibility, cost, risks and impacts.

3. The State commends the Department of Energy (DOE) for some of the positive changes in the department's revised position on the MRS (agreeing in part with the State's earlier assessments on rod consolidation and transportation, and favoring negotiated

approaches to siting), but the State criticizes significant shortcomings that remain in the DOE analysis including:

A) underestimating costs of the MRS

B) failing once again to optimize the No-MRS system

C) insufficiently assessing dual-purpose casks

D) underestimating the institutional difficulties in siting the MRS and in mitigating socioeconomic impacts, and

E) rationalizing the MRS with highly subjective and questionable judgments which ignore the increased cost and institutional feasibility problems associated with the MRS.

4. If the MRS Review Commission should favor some type of MRS based upon its evaluation of public policy issues, then the Commission should recommend to Congress that the following requirements be mandated in law:

A) a negotiated siting approach, whereby the MRS is located in a state, if and only if, the host state finds it acceptable and agrees through a signed and legally enforceable agreement with the federal government,

B) the increased costs to the nuclear waste management system attributable to the MRS are paid by, and only by, those utilities that directly use the MRS for storage, and

C) the strong linkages of the MRS schedule to the repository schedule contained in the Nuclear Waste Policy Amendments Act of 1987 remain in force.

Each point is expanded and elaborated in the following text. Additional documentation is provided in recent studies by the University of Tennessee. (References 1 and 2)

1. <u>The State of Tennessee stands by and advocates its original position that the MRS is not needed, that it is too expensive, and that a better solution -- the Integrated No-MRS system -- exists for managing the nation's nuclear waste.</u>

In June of 1985, shortly after DOE announced that Oak Ridge, Tennessee, was its preferred location for the MRS, the State of Tennessee -- executive and legislative branches -- began an intensive study of the MRS proposal. There was a careful independent review of the need, feasibility and costs of the nuclear repackaging plant. State agencies also examined the impacts of such a facility on the health, safety, and economy of the state.

The evaluation was conducted by state health, radiological and environment professionals, and by scientists from the University of Tennessee (UT), Vanderbilt University, and Oak Ridge Associated Universities. The study group was advised by national experts who served on a technical advisory panel. The 'need and feasibility' study, led by UT, uncovered inflated claims by DOE of both transportation benefits and on-site storage benefits of the MRS as well as an underestimation of its cost. Waste management systems with and without the MRS were compared and it was concluded that the system with the MRS was at least $2 billion more expensive to the nation. Moreover, the system with the MRS did not reduce transportation impacts over the system without the MRS, provided that easily-achievable transportation improvements were made. The recommended transportation improvements included using an optimal family of transport casks and increasing the percentage of spent fuel shipped by rail. The study recommended that DOE optimize the transport scheme whether or not the MRS facility was built, and that DOE consider using dual purpose casks for storage and transport.

Onsite consolidation of spent fuel rods was encouraged for reactors where this could be accomplished cost-effectively. This would have the benefit of reducing the number of cross-country spent fuel shipments.

The "need and feasibility study" also found that either system could operate safely, provided again that sufficient care and quality control were exercised by DOE. However, the study concluded that DOE had not yet demonstrated the engineering and economic feasibility of rod consolidation on the scale planned at the MRS. Of all the operations proposed for the MRS, the hot-cell consolidation operation had the greatest potential to generate accidents, unforeseen personnel exposure, low-level radioactive waste, and cost overruns.

Additional studies by UT (building on work begun at TVA) further defined the concept of an Integrated No-MRS system. In this system, advocated by the State, spent fuel would be kept in dry storage casks at reactor sites until the repository was ready, and then transported in large shipments using dedicated trains. While there are several mature technologies for dry storage of spent fuel, using a family of standardized dual purpose casks (ranging from 25 to 150 tons), purchased by DOE, leased to utilities for storage, was seen to have special advantages, particularly in minimizing the number of handling operations and shipments. DOE would work with individual utilities to upgrade access and cask handling facilities to accommodate the largest cask practicable. With plants not having rail access, barge or heavy haul transfer would be used, as appropriate, to move the large casks to a nearby railhead. Upon receipt at the repository, the dual purpose casks would be used for buffer storage and reused for transport when the repository opened. This system would not be dependent on any firm repository schedule or continuous repository operations, thereby providing great flexibility for the waste management system. Any consolidation and packaging operations deemed necessary could be performed partly at the reactor and partly at the repository. The study concluded that the integrated No-MRS system would, with sufficient emphasis on coordination and management, be cost-effective , minimize spent fuel handling and transportation impacts, minimize risks, and have the flexibility to accommodate delays in the opening and operation of the repository.

A separate UT study on socioeconomic impacts of the MRS concluded that negative public perceptions about the MRS could affect business development and tourism in the region. Negative perceptions about the facility could produce real economic impacts, and these impacts could not be easily offset. The negative economic effects started earlier than positive effects (with the siting decision) and affected a region extending far beyond the host county where most of the positive economic effects of tax revenues and jobs would occur. The DOE proposal did not sufficiently address the state, regional and local socioeconomic concerns.

In January 1986, the State of Tennessee formally announced its decision to oppose the MRS. The State's position concluded that nuclear waste was Tennessee's problem, too; that the MRS could be operated safely; but that it was unnecessary and therefore a waste of money. A better solution existed with the Integrated No-MRS system. The State felt that federal efforts to find and develop a permanent repository should not be diffused by pursuing an unnecessary and overly expensive MRS.

2. <u>The Tennessee Valley Authority position on MRS (January 17, 1989 statement to the MRS Commission) and two recent studies conducted by the University of Tennessee validate the State's position and document that:</u>

A) <u>the integrated No-MRS system is technically feasible, cost-effective, and has many advantages;</u>

B) <u>the MRS is significantly more expensive than the Integrated No-MRS system; and</u>

C) <u>the Integrated No-MRS system is by far the most preferred system, taking into account all public policy issues including technical feasibility, institutional feasibility, cost, risks and impacts.</u>

The Tennessee Valley Authority is expected to pay 5 to 10 percent of the entire cost of the national nuclear waste program since TVA is expected to produce approximately that percentage of the nation's forecasted nuclear generation. The TVA is vitally interested in the MRS proposal, both with respect to the cost impact to ratepayers, and with respect to the technical and institutional feasibility of implementing the waste system for all nuclear utilities.

TVA's examination of the cost implications of on-site storage facilities versus a centralized federal storage facility (MRS) revealed that on-site storage would be far less costly. Additional onsite storage capacity for all TVA reactors through the year 2013 would cost about $70 million in constant 1988 dollars. In contrast, TVA's increased contribution to the nuclear waste program, due to adding an MRS to the national waste system, would be between $130 million and $215 million.

This cost analysis led TVA to the conclusion that any centralized nuclear waste storage facility should be funded on a "user-pays" basis. If the storage components of an MRS were financed through the Nuclear Waste Fund, TVA, and other utilities with similar onsite storage potentials, would experience a cost penalty. In effect, these utilities would be paying twice for additional spent fuel storage; they will have to pay for their own additional on-site storage due to recognized delays in bringing the MRS and the entire waste management system up to a full operational fuel acceptance schedule, and they would pay into the nuclear waste fund their share of the additional cost of MRS.

Beyond cost considerations, the TVA has concluded that there are other considerations of technical and institutional feasibility that favor a nuclear waste program without an MRS. As cited by TVA these considerations are:

a. <u>systems reliability:</u> Once in-plant pools are filled, the breaking of any link in the MRS chain -- shipment to the MRS, equipment malfunction, safety questions, licensing difficulties -- could bring the waste management system, and eventually our nuclear plants, to a screeching halt.

b. <u>focus on the primary goal of deep geologic disposal of nuclear waste:</u> Principal reliance on onsite storage of spent fuel until a repository is built will discourage delays and enhance the prospects of a permanent geologic repository.

c. <u>optimal systems benefits:</u> The benefits attributed to the MRS proposed by DOE can be achieved by onsite storage in conjunction with other waste system modifications, including a user-funded MRS.

d. <u>Intent of Congress:</u> Principal reliance on onsite storage facilities, with a Federal interim storage facility available for those utilities who need it, is consistent with the intent of Congress as expressed in section 131 of the Nuclear Waste Policy Act of 1982.

The State of Tennessee is in general agreement with the January 17, 1989 MRS position statement of the Tennessee Valley Authority. MRS, as presently proposed by DOE would burden Tennessee Valley ratepayers with unfair costs and would reduce the chances that a permanent nuclear waste disposal solution would be found.

A recent UT study (Hoskins, ref.1) compared three waste management systems: DOE's No-MRS system, DOE's I-MRS (as proposed to Congress in 1987), and Tennessee's proposed Integrated No-MRS system. For evaluating transportation impacts, four proxy measures were used -- casks-shipped, trip-miles, ton-miles, and cask-days. Casks-shipped is the number of casks used in transportation, and is related to the capital, operating and handling cost of moving casks and the occupational radiological dose related to handling. Trip-miles is the sum (one-way) of the individual trip miles required to move the fuel from the reactors to the repository (via the MRS if applicable). A single cask shipped by truck or rail, or a shipment of several casks on the same train, counts as one trip. Trip-miles is related to the potential number of shipping accidents, the cost of security, and public perceptions of shipping activity. Ton-miles is the gross weight of round trip shipments and an indicator of freight charges. Cask-days is the total number of days that loaded casks are in transit, and is a proxy measure for radiological dose commitment to the public and transportation workers.

The relative comparison of transportation impacts using the four proxy measures is given in Figure V.1 taken from reference 1. As indicated in the figure, the Integrated No-MRS system clearly has the lowest impacts for each of the four proxy measures.

The total waste management system life cycle costs were also compared for the three systems (Hoskins, ref. 1). Costs to both the Nuclear Waste Fund for developing and operating the system and to utilities for at-reactor storage are included. For the repository and the MRS beginning operation in 2003, the cost in millions of 1986 dollars for the three systems is given in Table V.5 from reference 1. As indicated, the Integrated No-MRS system is $1.17 billion cheaper thank DOE's No-MRS system and $3.11 billion cheaper than DOE's I-MRS system.

This comparison is in terms of nominal cost estimates based largely on preliminary conceptual designs for facilities (the repository and MRS) that have never been designed, licensed or operated. Past experience with such nuclear related facilities indicate that major cost increases are not uncommon and are to be expected. Consequently, cost comparisons were also done using a probabilistic analysis (calculating expected value of system costs) to account for uncertainties in the cost of various components of the system.

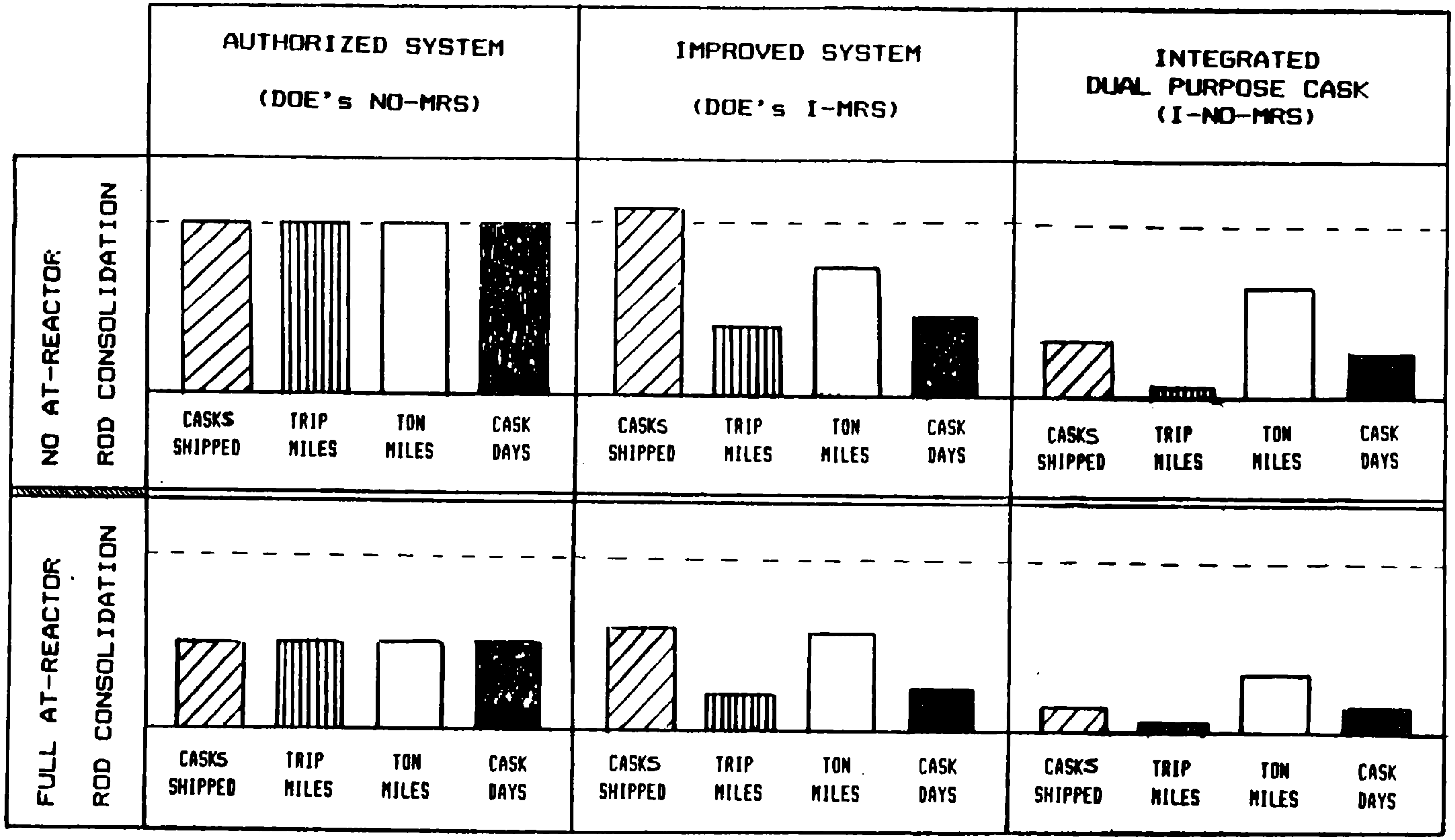

FIGURE V.1 - RELATIVE COMPARISON OF TRANSPORTATION SYSTEM IMPACT PROXY MEASURES FOR SPENT FUEL MANAGEMENT SYSTEM ALTERNATIVES

TABLE V.5 - TOTAL WASTE MANAGEMENT SYSTEM LIFE CYCLE COST

REPOSITORY (& MRS) OPERATION STARTING IN 2003

COST IN MILLIONS OF 1986 DOLLARS

	AUTHORIZED SYSTEM (DOE'S NO-MRS)	IMPROVED SYSTEM (DOE'S I-MRS)	INTEGRATED CASK SYSTEM (I-NO-MRS)
TRANSPORTATION:			
DEVELOPMENT	1,080	1,080	882
FAC. & OP.	1,928	1,623	1,370
SUB TOTAL	3,008	2,703	2,252
MRS FACILITY:			
DEVELOPMENT		125	
FAC. & OP.		2,699	
SUB TOTAL	0	2,824	0
REPOSITORY:			
DEVELOPMENT	5,631	5,631	5,631
FAC. & OP.	7,000	6,000	6,700
SUB TOTAL	12,631	11,631	12,331
COMPENSATION:			
REPOSITORY	1,450	1,450	1,450
MRS		365	
SUB TOTAL	1,450	1,815	1,450
ADMINISTRATION	1,823	2,023	1,710
DOE TOTAL	18,912	20,996	17,743
AT-REACTOR STORAGE	701	560	701
SYSTEM TOTAL	19,613	21,556	18,444
SAVINGS	(1,943)	BASE	(3,112)

In addition, because of uncertainties associated with the opening date of the repository, comparisons were also done assuming:

a) the repository and MRS both opening in 2008 (a five year delay) and

b) the MRS opening in 1998 and the repository opening in 2008 (which would require breaking linkages in the 1987 Amendments Act).

All of these cost comparisons are displayed in Table V.8 from ref. 1. As indicated, the Integrated No-MRS system is the least costly alternative by far, both in terms of nominal costs and expected value costs. For expected value costs, the Integrated No-MRS system is $1.24 billion cheaper than DOE's I-MRS system with the repository and MRS both opening in 2008, and $3.44 billion cheaper than DOE's I-MRS system with the MRS opening in 1998 and the repository opening in 2008. These cost comparisons demonstrate that the MRS is exceedingly expensive, and that DOE has not optimized its No-MRS case.

As DOE has frequently stated, factors other than cost need to be included in any assessment of waste management system alternatives. Nevertheless, a more expensive alternative should be required to demonstrate convincingly that other advantages are worth the increased costs.

The second UT study (Colglazier, ref. 2) examined public policy issues associated with the MRS. Seven different system alternatives were considered in the study, which were:

a) the Integrated No-MRS option (as proposed by the State of Tennessee)

b) the Backup MRS (an alternative to the repository, envisioned in the Nuclear Waste Policy Act of 1982)

c) DOE's 1987 I-MRS (proposed to Congress in 1987, with the MRS carrying out consolidation, packaging and storage functions)

d) the NWPAA-constrained MRS (with the MRS schedule linked to the repository schedule as specified in the 1987 Amendments Act)

e) DOE's 1989 I-MRS (proposed in 1989 with a storage-only MRS, a negotiated siting approach and a relaxation of the linkages)

f) a Co-located MRS (a storage-only MRS located on the Nevada Test Site without any schedule linkages) and

g) regional MRS's (spent fuel storage facilities located on several federal reservations).

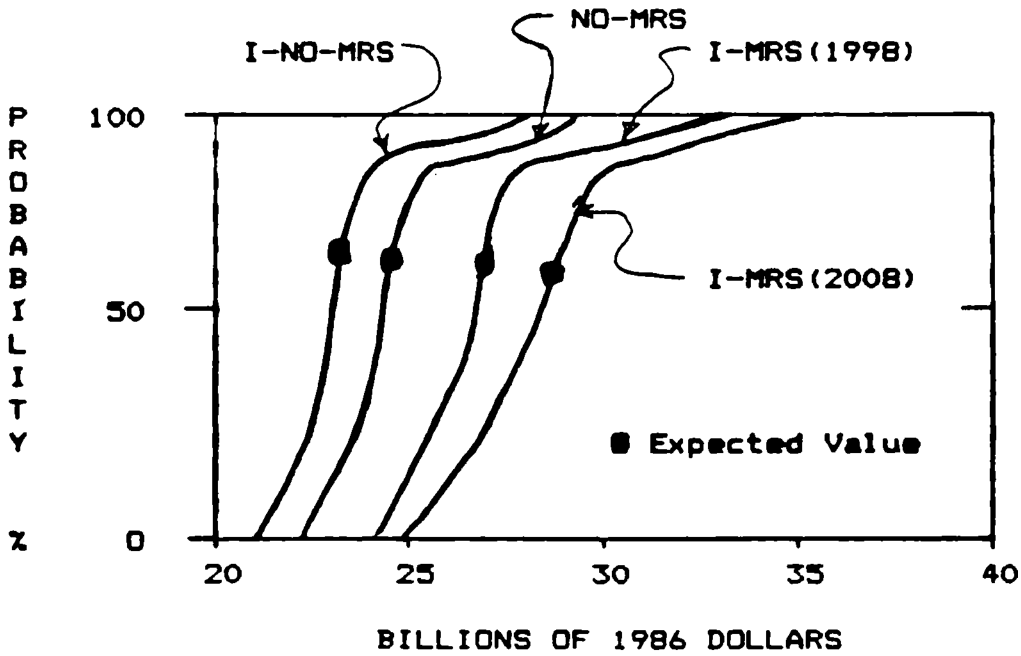

FIGURE V.8 - TOTAL LIFE CYCLE COST UNCERTAINTY FOR REPOSITORY OPERATION IN 2008

TABLE V.8 - COMPARISON OF NOMINAL AND EXPECTED TOTAL SYSTEM LIFE CYCLE COST FOR 2008 REPOSITORY OPERATION

MILLIONS OF 1986 DOLLARS

	NOMINAL COST		EXPECTED VALUE	
	AMOUNT	INCREASE	AMOUNT	INCREASE
DOE'S NO-MRS	23,150	1,236	24,777	1,239
DOE'S I-MRS(2008)	25,326	3,412	28,530	4,992
DOE'S I-MRS(1998)	24,106	2,192	26,974	3,436
I-NO-MRS	21,914	BASE	23,538	BASE

Two general criteria were selected for comparing options. The first criterion was to maximize the likelihood of successfully implementing in a timely manner a comprehensive national nuclear waste management system -- one that gives confidence about our ability to manage the waste for the long term -- taking into account uncertainties and reasonable future scenarios. The second criterion was to minimize the costs, risks and other impacts to people and the environment for this and future generations.

The first criterion was divided into four categories:

a) technical feasibility of the storage and packaging part of the system

b) technical feasibility of the disposal part of the system

c) institutional feasibility associated with the storage and packaging part, and

d) institutional feasibility associated with the disposal part. The category of "institutional feasibility of disposal" attempts to take into account three factors: relations with the host repository state, relations with those nuclear utilities and nuclear industries that favor early spent fuel acceptance by the federal government and relations with environmental groups.

The second criterion was divided into three categories:

a) cost of the system

b) risks associated with the system, and

c) other socioeconomic impacts associated with the system (in addition to the socioeconomic impacts of the repository).

In his report, the author, systematically evaluated each of the seven systems with respect to these criteria, assigned a rating to each and discussed his rationale for each score (see reference 2). This analysis of the public policy issues related to the DOE MRS proposal and its alternatives revealed that the Integrated No-MRS system as proposed by the state, provides more benefits to the system than the DOE I-MRS; other options rated lower. All of the options with an MRS had significant problems associated with their institutional feasibility.

Recognizing the inherent subjective nature of the analysis, the State of Tennessee concludes that its Integrated No-MRS is the superior alternative, when a careful and consistent assessment of the public policy issues is taken into account. Consequently, there is little or no public policy justification for accepting an MRS alternative with significantly higher costs.

3. The State commends the Department of Energy (DOE) for some of the positive changes in the department's revised position on the MRS (agreeing in part with the State's earlier assessments on rod consolidation and transportation and favoring negotiated approaches to siting), but the State criticizes significant shortcomings that remain in the DOE analysis including:

a) underestimating costs of the MRS

b) failing once again to optimize the No-MRS system

c) insufficiently assessing dual-purpose casks

d) underestimating the institutional difficulties in siting the MRS and in mitigating socioeconomic impacts, and

e) rationalizing the MRS with highly subjective and questionable judgements which ignore the increased cost and institutional feasibility problems associated with the MRS.

On May 25, 1989, DOE presented its current position on the MRS to the MRS Review Commission and made its recently-completed MRS System Studies available. DOE continues to support an MRS facility as an integral part of the waste management system, because DOE believes that the facility will help to meet certain strategic objectives. The MRS concept that DOE now favors is a phased approach which initially would not include rod consolidation or preparation of the final disposal package at the MRS. The MRS would receive, store and stage shipments of intact fuel to the repository and could be later expanded to perform additional functions if deemed necessary as the system matures. To fully realize the benefits that DOE perceives for the MRS, the department favors reducing the linkages between the MRS and the repository. The department also favors a negotiated siting approach that would be implemented by the Negotiator, an option established by the 1987 Amendments Act. However, DOE supports the MRS facility, even if the linkages are not modified and the department has to assume the responsibility for siting the MRS.

DOE concludes that several criteria -- health and safety, environmental impacts, socioeconomic impacts and transportation impacts -- do not significantly discriminate between system configurations with and without the MRS. DOE's preference for the MRS relies on strategic benefits related to:

a) institutional and regulatory experience with an MRS to facilitate timely disposal in a repository

b) acceptance of spent fuel from utilities at the earliest possible time

c) providing confidence in the timely development of the waste management system and demonstrating that the federal government is assuming its responsibility, and

d) providing flexibility to adapt to an uncertain future.

DOE's own cost estimates show that the MRS is significantly more expensive than DOE's No-MRS system. The net cost to the nation for a system with a basic (storage-only) MRS opening in the year 2000 and the repository in 2003 is $1.6 billion more than the No-MRS system. (An additional $.6 billion would be needed for an MRS with packaging functions, as in DOE's 1987 proposal.) For the repository delayed ten years and the basic MRS constrained by the NWPAA linkages, the net increased cost is $1.7 billion. For the repository delayed ten years and a basic MRS with relaxed linkages allowing its opening in the year 2000, the net increased cost over the No-MRS system is $1.3 billion. Thus, using the scenario most favorable to DOE's case for the MRS, using DOE's cost estimates and comparing to a poorly-optimized No-MRS system, the cost of an MRS system is still more than a billion dollars in excess of the No-MRS alternative.

The State commends DOE for modifying its position and agreeing with several of the State's earlier conclusions. DOE now agrees with the State that there is no identifiable benefit, at this time, that would justify the increased cost and complexity of incorporating spent fuel consolidation at the MRS.

The State believes that utilities should be free to consolidate spent fuel at reactor sites for increased storage, based on their own judgements, and DOE should accept consolidated fuel as well as intact fuel from utilities without any bias. Further, the DOE should give financial credit to utilities if consolidation results in cost savings to DOE for transportation or disposal.

DOE has still underestimated the costs of the MRS, failed once again to optimize the No-MRS system, and underestimated the institutional difficulties in siting the MRS and in mitigating socioeconomic impacts of the MRS. DOE's rationale for favoring the MRS system is extraordinarily subjective and weak. The State believes that there would be minimal learning experiences from licensing an MRS that would be relevant to licensing a repository.

By placing great weight on early acceptance of spent fuel by the federal government and using the MRS to provide increased confidence in the government's ability to perform on a timely basis, DOE has elevated early fuel acceptance to an equal or superior role to that of disposal in its mission, contrary to the NWPA and NWPAA. The NWPA clearly states that DOE will begin accepting spent fuel when the repository is ready.

Moreover, Tennessee would consider interim storage at an MRS as an indication that DOE is not effectively dealing with the disposal problem and that such actions are a prelude for allowing the MRS to become a defacto repository. The only step that will build confidence in the DOE program is orderly progress in development of the repository. DOE's analysis appears to be positioning the MRS to accommodate an extended delay in the repository program, which would decrease rather than increase confidence in the program.

DOE has made some incremental improvements toward optimizing the nuclear waste transportation system as was recommended by Tennessee. As evidenced in Task "F" of the recent DOE system studies, substantial improvements (compared to previous studies) in the capacity of from-reactor transportation casks were assumed.

Further improvement in the from-reactor transportation system has been made through the assumption of multiple cask shipments by special dedicated train rather than single-cask shipments in general commerce. Tennessee has consistently advocated this.

However, the benefits gained by the incremental transportation improvements mentioned above are completely overshadowed by DOE's continual failure to seek ways to increase the amount of nuclear waste which will move in large rail casks. The Task "F" assumption of a 55% rail and 45% truck modal mix of spent fuel moving from reactors is indefensible. This modal mix assumption is a dramatic change from the earlier DOE assumption of 70% rail and 30% truck shipments.

All DOE assumptions fall far below the 87% rail and 13% truck mix which Tennessee's research teams have found to be readily achievable. The state's position is that the number of cross-country spent nuclear waste shipments should be reduced by all feasible improvements which can be made at reactor sites. The goal is to move spent fuel into the largest practicable rail casks and move those casks to the nearest railhead.

DOE should work with utilities to upgrade rail access and cask handling facilities to move the largest casks practicable. Barge movements or heavy haul transfer equipment could be used at plants which do not have direct rail access. Transfer casks might be appropriate for some situations.

Data on reactor cask handling and transportation capabilities is being developed through DOE's Facility Interface Capability Assessment (FICA) project. Preliminary findings indicate that there are many feasible opportunities to upgrade the cask handling and rail transportation capabilities of reactors.

DOE has resisted the idea that the nuclear waste program should intrude "inside the fence" at reactor sites to optimize the transportation system. It is Tennessee's position that the failure to take these steps toward optimization will result in unnecessary radiological and other shipment risks to the general public.

Task C of the DOE System Studies attempted to evaluate eleven storage concepts for the MRS. The transportable metal cask or dual purpose cask was ranked eighth in order of preference due to a low licensing rating and due to high cost. Downgrading the transportable metal cask due to the lack of licensing experience and questions related to certification after a period of extensive storage appears to be inappropriate. There is no technical basis to support an assumption that either the fuel or the transportable metal cask would deteriorate during storage. At least one American vendor -- the Nuclear Assurance Corporation (NAC) -- has a firm commitment from another country to make dual-purpose casks a reality. NAC is now developing a dual-purpose version of its storage cask family, and plans to submit the Safety Analysis Report to the Nuclear Regulatory Commission for transport certification within a year. NAC expects to receive the Certificate of Compliance in 1991, with delivery of fabricated casks later in that year.

The cost analyses in DOE's evaluation greatly overstates the increase in cost of transportable metal casks over concrete storage casks. While DOE's estimates are within the range of possibilities for both concepts, the reference values used in the analysis are probably on the low side for concrete casks and on the high side for dual purpose casks. Production in large numbers in a competitive market would result in cost reductions for dual purpose casks. On this basis, transportable storage casks would have an expected cost of about $700,000 each as opposed to DOE's cost estimate of $1, 250,000. Therefore, the State concludes that DOE has not sufficiently evaluated the cost and benefits of dual purpose casks.

4. <u>If the MRS Review Commission should favor some type of MRS based upon its evaluation of public policy issues, then the Commission should recommend to Congress that the following requirements be mandated in law:</u>

a) <u>a negotiated siting approach, whereby the MRS is located in a state, if and only if, the host state finds it acceptable and agrees through a signed and legally enforceable agreement with the federal government</u>

b) <u>the increased costs to the nuclear waste management system attributable to the MRS are paid by, and only by, those utilities that directly use the MRS for storage, and</u>

c) <u>the strong linkages of the MRS schedule to the repository schedule contained in the Nuclear Waste Policy Amendments Act of 1987 remain in force.</u>

The State believes that, if the MRS Review Commission should recommend some type of MRS, then it should ensure that the possible negative impacts of the MRS on the repository program are minimized, that the host state and community bearing the burdens of the facility are fairly dealt with, and that the true beneficiaries of the facility pay the increased costs.

Because the MRS is not absolutely necessary, the federal government should be required to adopt a negotiated siting approach in order to minimize negative socioeconomic impacts and to ensure an equitable arrangement for the host state and community. Therefore, an MRS should be sited in a state, if and only if, it consents through a signed and legally enforceable agreement negotiated with the federal government. If the federal government cannot find a willing host, the Integrated No-MRS System is a perfectly feasible alternative.

The premise of the NWPA is that the beneficiaries of the program should bear the costs. Some utilities are already implementing additional on-site storage, and prudent utilities are planning to do so. No one can be confident that the federal government will accept spent fuel on schedule. Those utilities that are planning for expanded on-site storage will be paying twice if the MRS is built. The federal waste management program should not be used to force one utility to subsidize another utility, which would be the case if the MRS is funded from the Nuclear Waste Fund. Only those utilities that utilize storage at the MRS should be required to pay for the increased costs of incorporating the MRS in the waste management system. Each utility should be required to pay for its own storage costs until the fuel is shipped to the repository.

The State strongly concurs with and supports the position of the Tennessee Valley Authority, (expressed in testimony before the MRS Review Commission on January 17, 1989), that the best option is on-site storage, which is cheaper and more reliable, and that a user-funded approach be adopted for any federal MRS that is built.

The linkages between the MRS and the repository schedules were incorporated in the NWPAA in order to ensure that building the MRS would not reduce the federal government's commitment to developing the permanent repository. The linkages were made especially stringent in order to compensate for the fact that the repository program was focused on characterizing a single site rather than three sites, a strategy having a greater risk of failure for the repository program. Redundancy in the repository program was a powerful safeguard to assure that the national mission of nuclear waste disposal would move along expeditiously. An unrestricted MRS in conjunction with a single site undergoing characterization would be a retreat to a program without the proper safeguards and without the proper focus on the final goal, permanent isolation of nuclear waste from the human environment. Therefore, the linkages between the MRS and the repository specified in the NWPAA should remain in force.

Enclosed References

1. Raymond E. Hoskins, "A Systems Evaluation of the High-Level Nuclear Waste Management System Based on Integration of Dual Purpose Casks into the System as an Alternative to DOE's Proposed Monitored Retrievable Storage as an Integral Part of the System," Final Report to the Waste Management Research and Education Institute, the University of Tennessee, June 30, 1989. (The final report differs from the preliminary report of February 20, 1989, in pages 16 to 21 of the Summary and Conclusions section and in the Addendum, a Critique of DOE's MRS Position and MRS Systems Studies.)

2. E. William Colglazier, "Rethinking the MRS: Public Policy Issues Surrounding Monitored Retrievable Storage of Spent Nuclear Fuel, "Final Report, Waste Management Research and Education Institute, the University of Tennessee, June 30, 1989. (The final report differs from the preliminary report of February 28, 1989, presented at Waste Management '89, in the additional section on Comparing Options and the Conclusion section.)

RETHINKING THE MRS: PUBLIC POLICY ISSUES SURROUNDING MONITORED RETRIEVABLE STORAGE OF SPENT NUCLEAR FUEL

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Final Report to the State of Tennessee (1)
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ABSTRACT

Various options for utilizing monitored retrievable storage of civilian spent fuel were compared using the criteria of maximizing the likelihood of implementing successfully a comprehensive U.S. nuclear waste management system (taking into account scientific and institutional uncertainties) and minimizing the costs, risks, and other impacts. The near-term strategy that appears to be most robust for dealing with the key uncertainties is a combination of options having the following components: (i) rapid development of an integrated spent fuel management system that maximizes dry-storage at reactors using a family of dual purpose casks and plans for eventual shipment to Nevada via dedicated trains, (ii) consideration of a more scientific approach (i.e., more experimental, flexible, and evolutionary as well as more resilient to the inevitable scientific surprises that will occur) to the characterization and licensing of the potential repository site at Yucca Mountain rather than the current schedule-driven federal program, and (iii) consideration of an unconstrained MRS facility on the Nevada Test Site in case the evolutionary approach to repository development is adopted.

INTRODUCTION

This study, "Rethinking the MRS: Public Policy Issues Surrounding Monitored Retrievable Storage of Spent Nuclear Fuel," was conducted under contract for the State of Tennessee. A companion study, entitled "A Systems Evaluation of DOE's Proposed Integral-MRS System and an At-Reactor Storage Alternative Based on Systems Integration of Dual Purpose Casks," has been conducted by Raymond E. Hoskins, a private consultant, for the University of Tennessee as part of the same contract with the State. These studies represent the independent work of the two respective authors and do not necessarily represent the opinions of either the University of Tennessee or the State of Tennessee.

PURPOSE OF STUDY

The purpose of this study was to state clearly the goals and objectives of various MRS options, to evaluate and compare them using well-defined and reasonable criteria, and to assess their robustness under different scenarios about the future. Because of the large uncertainties that exist in making predictions about future events, especially in the realm dealing with human behavior and nuclear waste management, the robustness of policy options -- that is, their ability to deal with a range of future scenarios -- should be a key factor in selecting the best option.

When conducting a technical study on a controversial public policy issue like the MRS, it is important to lay out the technical parameters for each policy option in the most objective manner possible, so as not to constrain artificially choices for the public and elected officials. All too often the values of those conducting the technical studies intrude and distort the menu of choices through claims of technical constraints, which upon further investigation prove to be not totally accurate. When value or other subjective judgements are made in the conduct of a study, they should be explicit. I attempted to do so in this study. It is also important to bend over backwards to try to maintain credibility with the public in any assessment of controversial policy options. This requires at a minimum listening to and seriously considering diverse points of view. One of the biggest problems in the nuclear waste management field has been the lack of public trust and credibility in studies conducted by the government. The MRS Review Commission should be commended for doing an exemplary job in maintaining public trust in the conduct of its hearings; the Commission was scrupulously independent, open-minded, thoughtful, and fair to all participants.

MENU OF MRS CONCEPTS, OBJECTIVES, AND CRITERIA FOR EVALUATION

Several MRS concepts were considered in the conduct of this study. An attempt was made to state clearly and explicitly the goals of each; the protagonists in the MRS debate have often talked past each other because they see different goals and purposes for the MRS. The six generic MRS options that I considered were: the Backup MRS (an alternative or backup to the repository, available to accept spent fuel in a timely manner even if the repository is deferred indefinitely, which was the concept of the MRS envisioned in the Nuclear Waste Policy Act of 1982), the Integral MRS (as proposed by DOE in draft form in 1985 and to Congress in 1987, with the MRS carrying out consolidation, packaging, and storage functions as an integral part of the overall repository system), the NWPAA-constrained MRS (as authorized in the Nuclear Waste Policy Amendments Act of 1987, with linkages that tie construction of the MRS and its acceptance of spent fuel to progress on the repository), a Co-located MRS (located on the Nevada Test Site, currently forbidden by law), Regional MRS's (several storage-only facilities located on government property around the country), and the Decentralized MRS (storage at reactors with shipment directly to the repository, when the latter is ready, which in an optimized form is called the Integrated No-MRS option).

Some of the goals enunciated by proponents of the various options are as follows: A key objective of the Backup MRS is to provide a federal facility to ensure timely government acceptance of spent nuclear fuel from utilities in case the repository program encounters difficulties or delays. Key objectives of the DOE's Integral-MRS are to integrate the MRS into the repository system, thereby achieving benefits (according to DOE) in terms of reduced transportation impacts, earlier spent fuel acceptance, and expedited construction of a major portion of the federal waste management system. The Constrained MRS is a compromise option; the strong linkages of the MRS schedule to the repository schedule in the 1987 NWPAA were enacted to assure those skeptical of the MRS that the facility could not become an alternative to the repository. The Co-located MRS has the potential advantage of allowing early federal acceptance of spent fuel from utilities while affecting only the state that will be the likely host for the respository. Regional MRS's for storage at federal facilities have the potential advantage of early spent fuel acceptance and the perception of greater geographic equity. Storage at reactors has the advantage of maintaining pressure on the repository program, as well as being the option least likely to provoke public opposition since it is a straight-forward extension of the "status quo."

In order to compare options in a simple manner, two criteria were selected for the purposes of this study. The first is to maximize the likelihood of successfully implementing in a timely manner a comprehensive U.S. nuclear waste management system — one that gives confidence about our ability to manage the waste for the long term — taking into account uncertainties and reasonable future scenarios. The second criterion is to minimize the costs, risks, and other impacts to people and the environment for this and future generations. Evaluating options based on these two criteria requires considerable subjective judgment.

KEY ISSUES AND DEBATES

There are a number of key issues whose exploration can help to illuminate some of conflicting objectives and opinions held by different stakeholders in the MRS debate. To me, the most relevant issues are: (i) the linkage of the future of nuclear power to the nuclear waste management system, (ii) the linkage of the MRS to the repository, (iii) the likelihood of licensing the repository with no more than a slight delay from the original schedule, (iv) the political problems in siting the MRS, (v) the definition, optimization, and integration of the overall nuclear waste management system, (vi) the flexibility of the system to deal with uncertainties and different future scenarios, (vii) the potential economic and equity impacts on host communities, (viii) the potential economic and equity impacts on utilities and ratepayers, and (ix) the role of compensation, incentives, and different management schemes to deal with perceived impacts.

Linkages to the Future of Nuclear Power

No matter what happens to nuclear power in the future, there will be a considerable amount of nuclear waste to take care of. Nevertheless, perception of a linkage between a permanent solution to the nuclear waste problem and the future of nuclear power has existed implicitly in the minds of many and explicitly in a California law (upheld by the Supreme Court) and the Waste Confidence Proceedings of the Nuclear Regulatory Commission. Some of the pressure for rapid development of geologic disposal comes from groups who believe that solving the nuclear waste problem in a demonstrable way is essential to convincing the public to accept nuclear power for the long run. Many of the pro-nuclear groups feel that the federal government, because of its past promotion of nuclear power, has a special responsibility to take spent fuel in a timely manner from utilities as well as to show the public that the radioactive waste problem is solvable. Some environmental stakeholders use problems with nuclear waste management to increase public support for stopping nuclear power, but many of the environmental groups favor development of permanent geologic disposal in order to fulfill this generation's responsibility to fix a problem of its own making and to protect future generations.

Linkages to the Repository

The linkages of the MRS to the repository proposed by DOE in 1987 (that spent fuel would not be accepted at the MRS until the repository received a construction license from the Nuclear Regulatory Commission and storage capacity at the MRS would be capped at 15,000 metric tons) were put forward for the purpose of assuring the host state and other skeptics that the Integral MRS was not a substitute for the repository. In DOE's proposal, spent fuel would be kept only temporarily at the MRS, and permanent disposal would remain the primary goal of the federal program. The even stronger linkages enacted in the NWPAA of 1987 (i.e., construction of the MRS may not occur until the repository receives an NRC construction license, construction or spent fuel acceptance at the MRS must stop if repository construction or operation ceases, no more than 10,000 metric tons may be stored at the MRS until the repository opens, and no more than 15,000 metric tons of storage capacity is allowed at the MRS) can be understood as a manifestation of Congress wanting "iron-clad" guarantees to preclude the MRS from ever being a substitute for the repository or lessening society's commitment to development of a permanent solution.

While not in the majority, there are proponents of the Backup MRS who argue that this generation should not make irreversible decisions which may be costly to correct in the future. They argue that new technological developments may occur in the next century that could change our view of how to handle nuclear waste, that we currently know how to store safely in monitored engineered facilities where things can be corrected and repaired if something goes wrong, and that no reason exists to rush prematurely into developing an option of permanent disposal that has many scientific uncertainties and could lead to costly remedial action in the future. They argue that we should be more humble about our ability to project technological developments and human behavior over the next 10,000 years and that the fairest thing to do for future generations is to avoid costly mistakes and foreclosing options. Thus, some of the disputes surrounding the MRS have at their core deeply-held values and judgments, concerning how best to ensure future energy sources and to protect future generations.

Repository Uncertainties

From observing the repository program carefully over the past decade, I have concluded that considerable uncertainty exists concerning our ability to license the repository with no more than a slight delay from the original schedule. The U.S. has adopted a set of licensing criteria that requires considerable certainty about geohydrologic conditions at a site and release predictions based on modeling with a hypothetical set of long-term disruptive scenarios. The time frame for resolving these uncertainties with reasonable scientific assurance may be much longer than the time frame allowed in the licensing process, and may be impossible in the current regulatory framework. Proving with "reasonable expectation" that the EPA and NRC containment requirements and other licensing conditions will be met is an enormous and unprecedented challenge. The regulations themselves (or how they are interpreted) may have to evolve. As is often the case with frontier science, the more that is known may actually increase rather than decrease the uncertainties in the short run. It is very hard to speculate about a site until conditions are explored at repository depth, and there will always be credible scientists who will interpret the remaining uncertainties in ways different from DOE.

My own view is that a considerable period of time will be necessary to evaluate a repository site, and that a more experimental, evolutionary, flexible, and cheaper approach to site investigation, with less pressure from a rigid schedule, would be beneficial and, perhaps, avoid a perceived failure of the program in the mid-1990's.(2) More reliance on enhanced engineering barriers may be necessary to be comfortable with the irreducible scientific uncertainties. Therefore, I conclude that it is important to develop a policy option that minimizes the risks from an inability to license a repository on our current schedule. I want to make clear that I do favor a sound experimental program investigating the Yucca Mountain site at repository depth; the experience at the Waste Isolation Pilot Plant (WIPP) has taught us that things are not as simple underground as they seemed to be prior to sinking a shaft.

MRS Siting Problems

No governor, state legislature, or Congressional delegation from a potential host state has up to the present been receptive to the idea of importing high level nuclear waste to either an MRS or repository in their state. (There was one brief exception to this rule when the current governor of New Mexico supported accepting high-level waste at WIPP.)

Thus, one of the biggest downside problems for the MRS and the repository has been the likelihood that the siting decision would have to be imposed on the host state (even though there are communities that would be willing hosts). Congress was willing to do this in the case of the Yucca Mountain site in Nevada. Whether or not it would be willing to do so in the case of the MRS, a facility that is not absolutely necessary, and a state stronger politically than Nevada is problematical. Nevertheless, the fact that political opposition to accepting nuclear waste is so strong convinces me that proponents of an MRS facility need to give careful thought to how it can be sited. While there is no guarantee of success, negotiated approaches (which might be facilitated by the Negotiator, the position authorized in the NWPAA) are worthy of consideration -- negotiated approaches have had some success in the siting of other unwanted facilities. Nevertheless, I do not think it likely that a Governor can be convinced to sign a negotiated agreement to accept an MRS.

System Optimization

Raymond Hoskins has made a careful comparison of DOE's Integral MRS to an optimized Integrated No-MRS system.(3) In the Integrated No-MRS system, spent fuel would be kept in dry storage casks at reactor sites until the repository is ready, and then transported in large shipments using dedicated trains. While there are several mature technologies for dry storage of spent fuel, using a family of standardized transportable storage casks, ranging from 25 to 150 tons, purchased by DOE and leased to utilities, has special advanatages, particularly in minimizing the number of handling operations and shipments. DOE would work with individual utilities to upgrade access and cask handling facilities to accommodate the largest dual-purpose cask practicable. With plants not having rail access, barge or heavy haul transfer would be used, as appropriate, to move the large casks to a nearby railhead. Upon receipt at the repository, the dual purpose casks would be used for buffer storage and reused for transport when the repository opened. This system would not be dependent on a firm repository schedule or continuous repository operations, thereby providing great flexibility for the waste management system. Any consolidation and packaging operations deemed necessary could be performed partly at the reactor and partly at the repository.

As with our earlier studies for the State of Tennessee, Hoskins found that transportation impacts can be as small or smaller with an Integrated No-MRS system than with DOE's I-MRS (regardless of assumptions made about rod consolidation at reactors). Minimizing transportation impacts from spent fuel shipments is worthwhile whether or not there is an MRS.

Hoskins' economic comparisons are very important and worth careful attention. Using a fairly sophisticated probabilistic analysis and much of DOE's own cost data, he finds that the expected value for the I-MRS case, with the MRS opening in 1998 and the repository in 2008 (which would require relaxing the linkage between the MRS and the repository schedule), is $3.4 billion more than for the Integrated No-MRS case. If both the MRS and the repository do not open until 2008, then the expected value of the I-MRS case is $5.0 billion more than the Integrated No-MRS case.

DOE's own recent cost estimates (4) show that for the repository delayed ten years and a storage-only MRS opening in the year 2000, the net increased cost over DOE's No-MRS System is $1.3 billion. Thus, using the scenario most favorable to DOE's case for the MRS, using DOE's own cost estimates, and comparing to a poorly optimized No-MRS system, the MRS system is still more than a billion dollars over the No-MRS alternative.

I conclude that a separately-located MRS, as proposed by DOE, adds considerable costs to the nuclear waste management system. The Integrated No-MRS case, using dual purpose casks, is technically feasible, cost effective, and minimizes transportation impacts.

Flexibility

In order to take credit for flexibility in justifying a particular policy option, one must be precise about the future scenarios and uncertainties that the option is meant to deal with. To me, the biggest uncertainties in the storage and disposal of nuclear waste are the ability of DOE and Congress to overcome political opposition to siting an MRS and the ability of DOE to receive a repository license on a rigid schedule. The Integrated No-MRS case is far more flexible than DOE's I-MRS in dealing with the first uncertainty; neither case overcomes the latter problem.

Economic Impacts and Compensation

Whether or not it will materialize, real economic impact on the host state resulting from negative public perceptions about nuclear waste is a major concern for a state. This was the case with Tennessee and the MRS, and it is being seriously investigated by Nevada in its socioeconomic impact assessment of a geologic repository at Yucca Mountain. I believe that carefully tailored management strategies (particularly those that might increase public trust and credibility in the program) and compensation will be required to alleviate some of these concerns. Nevertheless, the perception of real economic impacts, as well as the feeling of being treated unfairly, are additional negative factors in trying to gain acceptance from a host state for the siting of either an MRS or repository.

The economic and equity impacts on utilities and ratepayers are also very important. I personally feel that too much money is wasted in the DOE program; it appears at times as if there are more managers than scientists in the program. There are too many other societal needs for us to assume that cost is no object in finding a permanent solution to the nuclear waste problem.

A major concern of utilities and their shareholders is the uncertainty from not knowing when the government will actually accept title and liability for spent fuel. Although utilities have contracts with DOE for spent fuel acceptance, there is no penalty for non-performance by DOE on the scheduled date. The Nuclear Waste Policy Act only requires that DOE begin accepting spent fuel when the repository is ready. Any prudent utility is examining on-site storage options for the life of the plant. An equity concern for those utilities that are making investments now for on-site storage is having to pay as well for a federal MRS which they may not need.

Even though it is technically feasible and cost effective to store on-site at reactors for the foreseeable future, as assumed in the Integrated No-MRS case, the pressure for government acceptance of utility spent fuel may increase in the 1990's, especially if the repository program begins to falter. This pressure for early federal acceptance of spent fuel is one of the reasons for the rigid repository development schedule in the NWPA. How to deal with this pressure is, for me, one of the major problems with the Integrated No-MRS option.

COMPARING OPTIONS

As stated previously, comparing the various MRS options on the basis of the two criteria used in this study requires considerable subjective judgment. Nevertheless, these types of judgments need to be made and stated clearly, for they are at the heart of the MRS decision (as similar judgments are for many other controversial public policy decisions).

The systems that were evaluated include the six described previously plus DOE's 1989 Integral MRS, which differs somewhat from its 1987 proposal. The Integrated No-MRS system assumes dual-purpose casks for storage at reactors and transport to the repository, as defined in detail in the system studies conducted by Hoskins and the earlier University of Tennessee reports. The Backup MRS system assumes that there will be early spent fuel acceptance at a federal facility and that the repository schedule can be delayed as long as necessary, perhaps many decades, to gain sufficient technical and societal confidence to proceed with permanent disposal. DOE's 1987 I-MRS system assumes rod consolidation and packaging at an MRS facility build in the eastern U.S., the repository developed on a tight schedule, and the MRS constrained by "weak" linkages to the repository schedule (as proposed by DOE). The NWPAA-constrained MRS assumes an MRS with the same functions as with DOE's 1987 proposal, the repository developed on a tight schedule, and strict adherence to the strong linkages specified in the 1987 act between the MRS and repository schedules. The Co-located MRS assumes a storage-only facility (at least initially) on the Nevada Test Site, no linkages to the repository schedule, and the repository developed on a relaxed schedule with a more evolutionary approach to characterization and licensing. Regional MRS's assume several storage-only facilities on federal reservations, weak linkages to the repository schedule, and the repository developed on a tight schedule. Of course, variations on all these options are possible. For example, the Integrated No-MRS System could be combined with some limited storage at federal facilities to provide a contingency in the event that severe storage problems develop at some reactor.

On May 25, 1989, DOE presented its current position on the MRS to the MRS Review Commission and made its recently-completed MRS System Studies available.(4,5) DOE continues to support an MRS facility as an integral part of the waste management system, because DOE believes that the facility will help to meet certain strategic objectives. The MRS concept that DOE now favors is a phased approach which initially would not include rod consolidation or preparation of the final disposal package at the MRS. The MRS would receive, store, and stage shipments of intact fuel to the repository, and could be later expanded to perform additional functions if deemed necessary as the system matures. To fully realize the benefits that DOE perceives for the MRS, the department favors reducing the linkages between the MRS and the repository. The department also favors a negotiated siting approach that would be implemented by the Negotiator, the position established by the 1987 Amendments Act. However, DOE supports the MRS facility, even if the linkages are not modified and the department has to assume the responsiblity for siting the MRS.

DOE concludes that several criteria -- health and safety, environmental impacts, socioeconomic impacts, and transportation impacts -- do not significantly discriminate between system configurations with and without the MRS. DOE's preference for the MRS relies on strategic benefits related to: (i) institutional and regulatory experience with an MRS to facilitate timely disposal in a repository, (ii) acceptance of spent fuel from utilities at the earliest possible time, (iii) providing confidence in the timely development of the waste management system and demonstrating that the federal government is assuming its responsibility, and (iv) providing flexibility to adapt to an uncertain future. In my comparison of options, I will assume the DOE's 1989 I-MRS system includes weak linkages to the repository schedule as in the department's 1987 proposal.

Rather than trying to use a formal decision-aiding tool, like multiattribute utility analysis to compare the system options, I opted for using a simple scoring of the options against four proxies for the first criterion and three for the second. The first criterion was divided into the following four categories: (i) technical feasibility of the storage and packaging part of the system, (ii) technical feasibility of the disposal part of the system, (iii) institutional feasibility associated with the storage and packaging part, and (iv) institutional feasibility associated with the disposal part. The category of "institutional feasibility for storage and packaging" refers primarily to political problems in siting the facility that stores spent fuel. The category of "institutional feasibility of disposal" attempts to take into account three factors: relations with the host repository state, relations with those nuclear utilities and nuclear industries that favor early spent fuel acceptance by the federal government, and relations with environmental groups. The second criterion was divided into three categories: (i) cost of the system, (ii) risks associated with the system, and (iii) other socioeconomic impacts associated with the system (in addition to the socioeconomic impacts of the repository). A grade ranging from "A" to "F" was given in each of these seven categories for each of the system options. The grade of "A" is intended to imply system performance about as good as realistically achievable. The grade of "D" is intended to imply an obstacle that very likely cannot be overcome. Assuming for simplicity equal weightings between the categories, an overall grade for each option was also given.

The MRS Report Card is given in Table 1. The rationale for the grades assigned in each category is explained below.

Technical Feasibility of Storage and Packaging

The storage of spent fuel in metal or concrete casks is a mature technology. For that reason, all of the options except for DOE's 1987 I-MRS and the NWPAA-constrained MRS were given a grade of A. DOE's 1987 I-MRS was given a grade of B+ because of the remaining issues associated

TABLE 1. MRS REPORT CARD: THE AUTHOR'S SUBJECTIVE EVALUATION OF WASTE MANAGEMENT SYSTEM ALTERNATIVES[1]

		Technical Feasibility		Institutional Feasibility		Societal Impacts			Final Grade
		Storage & Packaging	Disposal	Storage[2] & Packaging	Disposal[3]	Cost	Risks	Other Impacts[4]	
1.	Integrated No-MRS	A	C	A	B-	A	A	A	A-
2.	Backup MRS	A	B+	D-	D	B-	A-	C	C+
3.	DOE's 1987 I-MRS	B+	C	D	B+	C	B+	C	C+
4.	NWPAA-Constrained MRS	A-	C	D+	B-	C-	A-	C	C+
5.	DOE's 1989 I-MRS	A	C	D+	B+	B-	A-	C+	B-
6.	Co-located MRS	A	B+	C-	B-	A-	A	A-	B+
7.	Regional MRS	A	C	D-	B	C	A-	C-	C+

1. The grade of "A" is intended to imply system performance about as good as realistically available. The grade of "D" is intended to imply an obstacle that very likely cannot be overcome.

2. Institutional feasibility for storage and packaging refers primarily to political problems in siting the facility that stores spent fuel.

3. Institutional feasibility of disposal attempts to take into account three factors: (l) relations with the host repository state, (2) relations with those nuclear utilities and nuclear industries that favor early spent fuel acceptance, and (3) relations with environmental groups. Some people might lower the grade under this category for the Co-located MRS from B- to perhaps C-, which would lower the final grade for the Co-located MRS from B+ to B.

4. Other impacts refers to socioeconomic impacts in addition to those associated with the repository.

with engineering feasibility of rod consolidation on the scale planned at the MRS. Of all the operations proposed for the MRS, the hot-cell consolidation operation had the greatest potential to generate accidents, unforseen personnel exposure, low-level radioactive waste, and cost overruns. Nevertheless, dry consolidation in hot cells at the MRS is very likely technically feasible given additional demonstration and technology development. The NWPAA-constrained MRS, which also includes rod consolidation at the MRS, was given a grade of A- because additional time would be available to demonstrate the technology before facility design was finalized.

Technical Feasibility of Disposal

All of the options except the Backup MRS and the Co-located MRS were given a grade of C. This scoring reflects my judgment, stated presiously, that trying to develop and license the repository on a tight schedule, driven by political pressure, would very likely lead to problems in proving technical licensing requirements and create the perception of a failed program. The Backup MRS and Co-located MRS were given grades of B+ because these options would allow for a more evolutionary and methodical approach to site characterization, with the flexibility to take as much time as necessary to develop technical confidence in permanent disposal.

Institutional Feasibility of Storage and Packaging

Institutional feasibility of storage and packaging refers primarily to political problems in siting the facility that stores spent fuel. The Integrated No-MRS option was given an A because of my perception that continued storage at reactors wold not lead to any serious political problems over the next several decades, either with local communities or public utility commissions. (In the long run, public opposition to continued on-site storage may grow, particularly as reactors are shut down, but getting people to accept the "status quo" is considerably easier than getting them to accept a new facility that stores other people's waste.) The Backup MRS was given a D- because of the intense public opposition (at least at the state and Congressional level) to accepting a new storage facility storing indefinitely the nation's high-level waste. DOE's 1987 I-MRS and the NWPAA-constrained MRS were given slightly higher grades — D and D+, respectively — because of the existence of linkages to assure the public that the repository program would go forward. DOE's 1989 I-MRS also received a D+ because of DOE's stated preference for a negotiated siting approach. These low grades are a reflection of my view that no state will be a willing host and, because the MRS is not absolutely necessary, Congress will be reluctant to impose it on a state that is objecting vigorously. The Co-located MRS was given a C- because Congress might be somewhat more willing to impose an MRS on Nevada since the perception already exists that Nevada will receive the nation's nuclear waste. However, the leadership of Nevada is currently very much opposed to an MRS (as with the repository), and the Secretary of Energy has recently assurred the state that the department has no intention of putting an MRS in Nevada. Regional MRS's were given a grade of D- because of the intense opposition expected from states like South Carolina, Tennessee, and Washington.

Institutional Feasibility of Disposal

Institutional feasibility of disposal attempts to take into account three factors: (i) relations with the host repository state, (ii) relations with those nuclear utilities and nuclear industries that favor early spent fuel acceptance, and (iii) relations with environmental groups. The Integrated No-MRS system and the NWPAA-constrainted MRS were given grades of B- to reflect the continued opposition of Nevada to the repository, but the grudging acceptance of the current program by most other parties. The Backup MRS was given a D because of the adamant opposition of the environmental community and its Congressional supporters to any option that they feel does not assure permanent protection of the environment and future generations. DOE's 1987 and 1989 I-MRS systems were given B+ to reflect an increased approval of (or greater reluctance to criticize) the DOE repository program from those nuclear utilities and their Congressional supporters who would receive guarantees of early spent fuel acceptance. While not happy with any option having an MRS, the environmental community would probably be as tolerant of the disposal part of these systems as they are of the current DOE repository effort. The Co-located MRS was given a B- to reflect the increased opposition from Nevada. Some observers might lower this grade even further, perhaps to a C-, perceiving that the Co-located MRS might make relations between DOE and Nevada over the repository even worse than they are today.

Cost

The Integrated No-MRS was seen as the most cost-effective option, and therefore was given an A. The increased costs of the other options are reflected in their lower grades. MRS systems with consolidation (DOE's 1987 I-MRS and the NWPAA-constrained MRS) are more expensive than storage-only options. The Regional MRS system results in increased costs because of the multiple sites. The Co-located MRS system is given a grade of A- because its costs should only be a modest increase over those of the Integrated No-MRS system, because the Co-located MRS can serve as the lag storage and packaging facility for the repository.

Risks

The risks of all the options are judged to be low, resulting in grades ranging from B+ to A. Options with a minimum of handling operations were given slightly higher grades. DOE's 1987 I-MRS was given a B+ to reflect the possible problems from having to finalize the design of the consolidation operation rather quickly.

Other Impacts

The category of other impacts refers to socioeconomic impacts in addition to those associated with the repository. Therefore, the Integrated No-MRS option was given an A since additional impacts are minimal. Grades in the C range were given to options with an MRS located outside of Nevada. Regional MRS's received a C- because of the multiple sites. DOE's 1989 I-MRS received a C+ because negotiated siting might produce a compensation package more acceptable to the host state. The Co-located MRS received an A- because the impacts in addition to those associated with the repository program would probably not be large.

Final Grade

The highest ranked option is the Integrated No-MRS system (grade of A-), followed by the Co-located MRS (grade of B+) and DOE's 1989 I-MRS (grade of B-). If the Co-located MRS were given a C- in the category of "institutional feasibility of disposal," then its overall grade would have been lowered to B. While all these grades are subjective and qualitative, the reader can provide his or her own scores as well as assign different weights (rather than equal weights) to the seven categories.

The difference between the two top-ranked options is primarily in two categories: technical feasiblity of disposal and institutional feasibility of storage and packaging. The Co-located MRS ranks higher in technical feasibility of disposal; the Integrated No-MRS system ranks higher on institutional feasibility of storage and packaging. Note that these are the only system options that, in my judgment, do not have a grade of D in one or more categories. For me, a grade of D implies an obstacle that very likely cannot be overcome.

If I had used differential weights, I would have placed increased emphasis on the criterion of "technical feasibility of disposal." This would have raised the final grade of the Co-located MRS option.

CONCLUSIONS

The key problems that any high-level waste management system has to contend with are: (i) overcoming the technical problems in licensing an unprecedented facility that will achieve permanent disposal and (ii) overcoming the institutional problems in siting a centralized federal storage facility that is not absolutely necessary. The two highest ranked systems from my comparison of options were the Integrated No-MRS System and the Co-located MRS. In my view, the Integrated No-MRS System suffers from the first problem; the Co-located MRS suffers from the latter problem.

The national strategy that appears to me to be most robust for dealing with the uncertainties caused by these two problems is one that combines the two highest-ranked systems, that is, a strategy that perserves the option of going in either direction after more information is obtained from DOE's efforts at characterizing Yucca Mountain. Such a strategy is facilitated by the fact that both systems require DOE to make plans for shipping spent fuel from reactors to Nevada. The strategy for pursuing this combined system would have the following components:

(i) Rapid Development Of An Integrated System Maximizing Dry-Storage At Reactors Using Dual Purpose Casks - Because spent fuel is going to be stored at reactors for a long time, the highest priority for the federal government is to do more to help utilities to plan for life-of-plant storage. The most effective integrated system that maximizes at-reactor storage uses dual-purpose casks and plans for eventual shipment via dedicated trains. Each utility would be responsible for paying its own storage costs, but the federal government would purchase and lease dual-purpose casks for use by the utilities. If federal acceptance of spent fuel is significantly delayed, this system can ensure that spent fuel is managed safely for as long as necessary.

(ii) Consideration Of A More Experimental Approach To The Repository And A Co-located MRS - The government needs to plan for a more experimental, scientific, and evolutionary approach with a relaxed schedule and lower cost for site characterization at Yucca Mountain, and careful consideration needs to be given to the option of an unconstrained MRS at the Nevada Test Site (i.e., no linkages to the repository development schedule). The evolutionary approach for repository development may be needed in order to avoid a quite likely scenario, that DOE will be unable to license the repository in the 1990's and this will be perceived as a failure of the program leading to more uncertainty and turmoil. Removing the pressure for the current repository development schedule to allow this evolutionary approach to repository development may require some type of MRS, and the Co-located MRS is probably the only option that might overcome the institutional barriers to a federal storage facility. Nevertheless, gaining societal approval for an evolutionary approach to repository development and a Co-located MRS are daunting challenges. Both possibilities need to be discussed and explored as DOE acquires more information in its repository development effort.

The Co-located MRS has serious difficulties because of Nevada's intense opposition, the promise by the Secretary of Energy that DOE would not pursue this option, and the existing law prohibiting co-location. Forcing an MRS on Nevada would compound the state's feelings of being unfairly treated, which might exacerbate problems with the state in characterizing the Yucca Mountain site. Designating an unconstrained MRS at the Nevada Test Site would require changing the law and probably overriding once again the wishes of the state, which I would regret having to do, having argued in other studies (6) for developing radioactive waste policies more widely perceived as fair. If Congress should override Nevada and authorize an MRS on the Nevada Test Site, it could provide additional rights, compensation, and oversight powers for the state, including perhaps final authority over repository loading and closure.

The advantages of the Co-located MRS option include: (i) removing pressure being exerted by utilities and Congress for a rigid repository development schedule, which might avoid a perceived failure of the repository program in the 1990's, (ii) allowing for firm transportation planning now, (iii) avoiding the political fight from trying to site an MRS in another state, (iv) avoiding additional sites being concerned about special economic impacts since the current public perception is that Nevada will get the nation's nuclear waste, (v) avoiding significant increased costs from an MRS located elsewhere, (vi) gaining the flexibility to make decisions about rod consolidation at some later time, and (vii) changing the debate from where nuclear waste will reside to which technical option (storage or disposal) is the more prudent decision for this generation. It may turn out that Yucca Mountain proves unacceptable for a repository license. In that case, a new siting effort and many years will be required before the U.S. has a permanent disposal solution, but monitored engineered storage at the Nevada Test Site can continue as long as necessary. The biggest challenge for this option is convincing the public that this is a prudent course, one that gives confidence in our ability to manage nuclear waste safely for the long term and maintains our commitment to develop a permanent solution in a scientifically-sound manner. I would also hope that the federal government could bend over backwards in trying to accommodate the wishes of the State of Nevada if the decision is made to site an MRS in Nevada.

In any event, the decision of which path to follow, either the Integrated No-MRS or the Co-located MRS system, can be postponed for several years. If problems develop in DOE's characterization and licensing effort at Yucca Mountain, Congress will have to grapple with the hard choices outlined above.

If Congress should adopt the option of an unconstrained MRS in a state other than Nevada, it should require the users of federal storage to pay for the significantly increased costs to the overall system and DOE to adopt a negotiated siting approach (using the Negotiator) in order to minimize negative socioeconomic impacts on the host state and community. My own view is that it is unlikely to find a host state willing to accept an MRS, or users willing to pay the increased system costs themselves, but I am open to being convinced otherwise. If the federal government cannot find a willing host or funders, the Integrated No-MRS system is a perfectly acceptable backup.

REFERENCES

1. This paper is a revised version of the oral and written testimony presented to the MRS Review Commission on February 16, 1989, in Atlanta, Georgia, and the paper present at Waste Management '89 in Tucson, Arizona, on February 28, 1989 (published in the proceedings).

2. This approach has also been suggested by Luther Carter in a paper presented at the meeting of the American Association for the Advancement of Science in San Francisco on January 17, 1989, which will be published by the Forum for Applied Research and Public Policy, and by Chris Whipple in a paper presented at the Waste Management '89 Conference on February 27, 1989, which will be published in the proceedings.

3. Raymond E. Hoskins, "A Systems Evaluation of DOE's Proposed Integral-MRS System and an At-Reactor Storage Alternative Based on Systems Integration of Dual Purpose Casks," prepared under contract for the Energy, Environment, and Resources Center of the University of Tennessee, final report, June 30, 1989.

4. "MRS Systems Study Summary Report (Task J)," Office of Civilian Radioactive Waste Mangement, May, 1989.

5."DOE Position on the Monitored Retrievable Storage (MRS) Facility," Office of Civilian Radioactive Waste Management, U. S. Department of Energy, May, 1989.

6. E. W. Colglazier, "The Relation of Equity Issues to Risk Perceptions and Socioeconomic Impacts of a High-Level Waste Repository," Proceedings of the Waste Management '89 Conference, University of Arizona, Tucson, AZ.

A SYSTEMS EVALUATION

OF THE

HIGH-LEVEL NUCLEAR WASTE MANAGEMENT SYSTEM

BASED ON

INTEGRATION OF DUAL PURPOSE CASK INTO THE SYSTEM

AS AN ALTERNATIVE TO

DOE'S PROPOSED

MONITORED RETRIEVABLE STORAGE FACILITY

AS AN INTEGRAL PART OF THE SYSTEM

June 30, 1989

FINAL REPORT

by

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NOTICE

This report is an account of work performed under contract to the Waste Management Research and Education Institute at the University of Tennessee with financial support by the State of Tennessee. Beyond agreement on the general scope of work the contents of the study is independent work by the author.

Comments or suggestions about any aspect of this report are welcomed by the author.

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TABLE OF CONTENTS

I - SUMMARY AND CONCLUSIONS

This report is an account of independent study performed by the author under contract to the University of Tennessee with support from the Tennessee State Planning Office. The results do not necessarily represent opinions of the University of Tennessee or the State of Tennessee.

A systems approach was taken to perform a comparative evaluation of waste management system configurations. DOE's I-MRS concept is compared to an alternative concept based on integration of a standardized family of dual purpose casks into the system without a central MRS facility (I-NO-MRS). These casks are designed for at-reactor storage and transportation of spent fuel and range in nominal size from 25 to 150 tons and can accommodate consolidated as well as intact fuel assemblies. In this approach, at-reactor storage is provided through a combination of re-racking and rod consolidation in reactor storage pools augmented as necessary by dry storage in dual purpose cask or compatible concrete storage modules. The largest practical casks are used to efficiently accommodate circumstances at each reactor site. These casks become the transportation fleet when the repository is available and are also used for buffer storage at the repository. Multiple cask shipments are made by special dedicated trains. Where rail access to a reactor site is not practical the casks would be moved to a nearby railhead by barge or heavyhaul vehicle. If there should be an extended delay in the repository and it becomes desirable to began decommissioning reactor sites these cask can be used to move fuel to another site for interim storage and shipment to the repository without removing the fuel from the cask. However, there is no need to decide to implement this option until well after the turn of the century.

The SYSTEMS APPROACH is a disciplined method for developing the best configuration for a complex system. It involves the use of defined criteria to design, optimize, and evaluate alternative system configurations based on the customers values to best perform a clearly defined mission in the environment in which the system must function. A review of the background related to DOE's I-MRS proposal and DOE's systems practices indicate that DOE has not used a SYSTEMS APPROACH and has avoided comparing their I-MRS concept to an optimized system based on at-reactor storage.

Use of the SYSTEMS APPROACH requires identification of the CUSTOMER as well as the VALUE CRITERIA by which the CUSTOMER will judge the systems ability to carryout its MISSION of safe and environmentally acceptable high-level waste disposal. While the general public is the primary customer it is difficult to determine public values on complex issues. There are a number of stakeholders who do take positions and have some influence. A hierarchy of stakeholders, based on the authors ranking, is illustrated in Table I.1. All of the stakeholders might not agree with this ranking. Acceptance if not support of these stakeholders is desirable for successful implementation of any waste management system configuration. It will be necessary to develop a working consensus that can be sustained over several decades. The values of each stakeholder is important, but those closest to the public should carry the most weight.

TABLE I.1 - A HIERARCHY OF STAKEHOLDERS IN THE CIVILIAN RADIOACTIVE WASTE MANAGEMENT PROGRAM

The General Public

Affected State Governments

Congress

Electric Ratepayers

Public Interest Groups

Public Owned Utilities

Public Utility Commissions

Investor Owned Utilities

Nuclear Industry Suppliers

DOE's OCRWM

DOE's Field and Program Offices

DOE's Laboratories and Contractors

DOE Headquarters

The value criteria used in this evaluation along with a qualitative comparison for each criteria is shown in Table I.2. One star indicates that the concept is somewhat better, two stars indicate the concept is clearly better, and three stars indicate that the concept is decisively better. This is a composite value structure based on workshops with groups representing Public, Government and Technical interest for use in optimization and evaluation of alternative waste management system configurations. It is an appropriate basis for reviewing the status and adequacy of the systems advantages and disadvantages of DOE's proposed I-MRS compared to alternative at-reactor storage as required by the 1987 Nuclear Waste Policy Act (NWPA) Amendments.

No effort was made in this evaluation to develop weighting factors for each of these criteria. The apparent superiority of the I-NO-MRS concept is due to:

- o standardization,
- o integration, and
- o design to be responsive customer values.

It is not clear what values DOE used in the design and optimization of their I-MRS concept.

The first two criteria lend themselves to quantitative comparison. The remaining six are compared in qualitative terms based primarily on stakeholder testimony before the MRS

TABLE I.2 - RELATIVE COMPARISON OF VALUE CRITERIA

EVALUATIONS FOR I-MRS AND I-NO MRS SYSTEM CONFIGURATIONS

NOTE: * SOMEWHAT BETTER

* * CLEARLY BETTER

* * * DECISIVELY BETTER

CRITERIA	DOE's I-MRS CONCEPT	DUAL PURPOSE CASK I-NO-MRS CONCEPT
1. Health and Safety:		
Public		* * *
Occupational		* * *
2. Economic		* * *
3. Environmental:		
Near-term		*
Long-term		* *
4. Political:		
Acceptability		* *
Public Confidence:		
In DOE		* *
Political will		* * *
Local and State Attitudes		* *
5. Social (Fears and Anxieties)		* *
6. Fairness:		
Liability		*
Equity:		
Geographic		* * *
Intergenerational		* *
Interutility		* *
Utility-Ratepayer		* * *
Government-Utility	* *	
7. Scheduling (Repository)		* * *
8. Flexibility:		
Technical		* * *
Institutional		* * *

Review Commission with deference to those views closest to the public. The evaluation is discussed in detail in Chapter V of this report and is briefly summarized here.

HEALTH AND SAFETY is divided into public and occupation components which can be addressed as impacts related to transportation and those related to spent fuel handling operations. Figure I.1 shows a comparison of transportation impacts in terms of four proxy measures:

- o CASK SHIPPED is a measure of transportation related occupation radiological dose commitments at nuclear facilities.
- o TRIP-MILES is a measure of apparent shipping activity, risk of a shipment being in an accident, and the cost of security, monitoring and emergency response.
- o TON-MILES is an indicator of freight charges for gross shipping activity.
- o CASK-DAYS is a measure of radiological dose commitments to the public and transportation occupational workers.

It is assumed that the I-MRS would be located in the east as DOE has proposed. It is seen that DOE's I-MRS does significantly reduce TRIP-MILES and CASK-DAYS with some decrease in TON-MILES and increase in CASKS SHIPPED compared to their NO-MRS concept. The I-NO-MRS concept significantly reduces CASK SHIPPED, TRIP-MILES, and CASK-DAYS while achieving some reduction in TON-MILES compared to DOE' I-MRS concept as indicated in Table I.3. The principal comparison

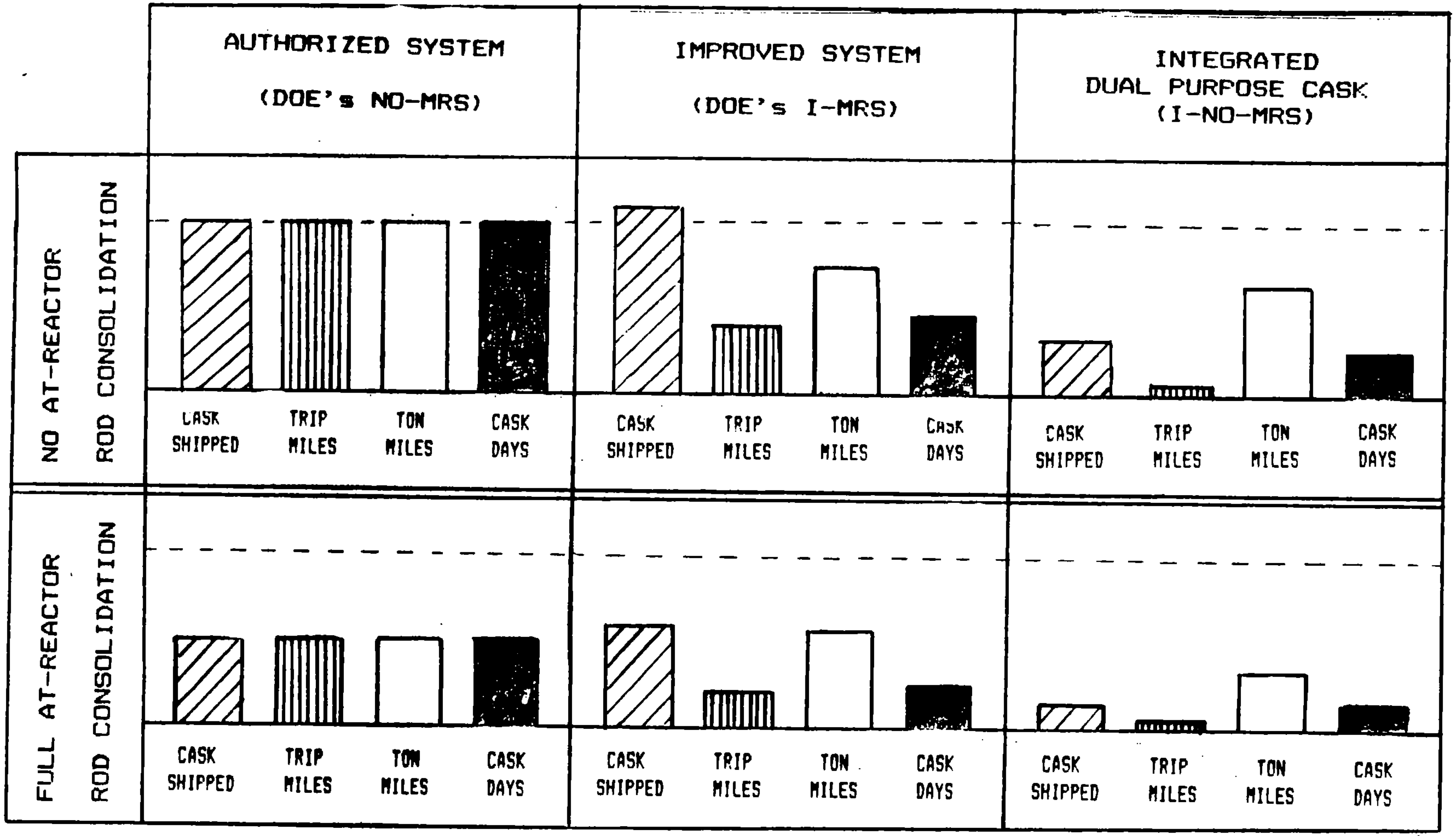


FIGURE I.1 - RELATIVE COMPARISON OF TRANSPORTATION SYSTEM IMPACT PROXY MEASURES FOR SPENT FUEL MANAGEMENT SYSTEM ALTERNATIVES

TABLE I.3 - REDUCTION IN TRANSPORTATION IMPACT MEASURES FOR THE DUAL PURPOSE CASK I-NO-MRS CONCEPT COMPAIRED TO DOE's INTEGRAL MRS SYSTEM CONFIGURATION CONCEPT

NO AT-REACTOR CONSOLIDATION:	
CASK SHIPPED	72 % LESS
TRIP-MILES	88 % LESS
TON-MILES	16 % LESS
CASK-DAYS	50 % LESS
FULL AT-REACTOR CONSOLICATION:	
CASK SHIPPED	74 % LESS
TRIP-MILES	88 % LESS
TON-MILES	42 % LESS
CASK-DAYS	58 % LESS

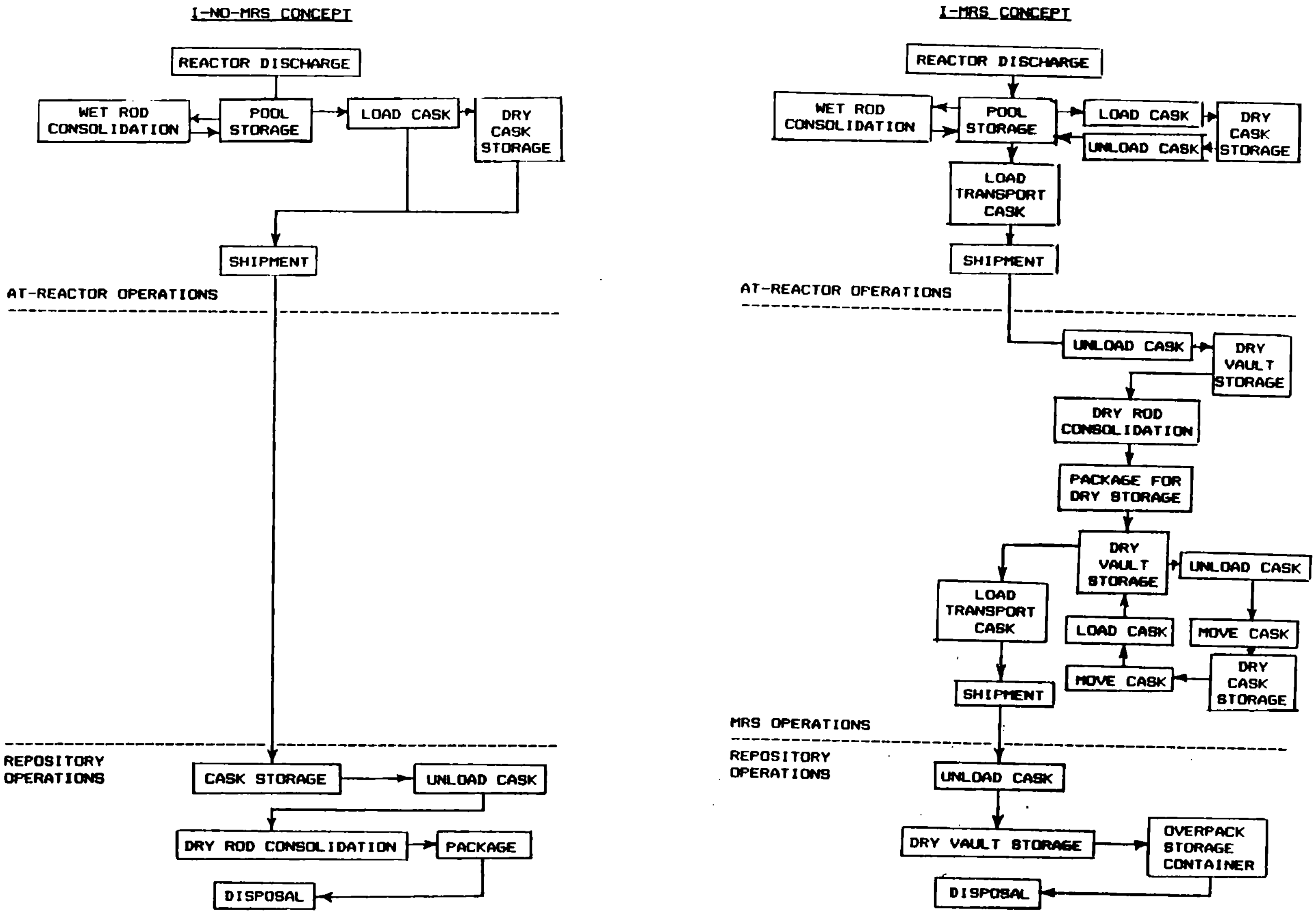


FIGURE I.2 - COMPARISON OF SPENT FUEL HANDLING OPERATIONS is based on NO AT-REACTOR ROD CONSOLIDATION. Results are also shown for FULL AT-REACTOR ROD CONSOLIDATION which substantially reduces transportation impacts for all the concepts. At this time, it is not possible to accurately predict the amount of at-reactor rod consolidation that will take place. Figure I.2 compares spent fuel handling operations. It is seen that the number of times the fuel is handled and shipped is greatly reduced in the I-NO-MRS concept.

ECONOMIC cost are compared in Table I.4 as TOTAL SYSTEM LIFE CYCLE COST including compensation payments to the states and the cost of providing at-reactor storage. These comparisons use DOE at-reactor storage cost estimates from their "Initial Version: Dry Cask Storage Study", and DOE life cycle cost estimates adjusted to reflect 1987 NWPA Amendment conditions. This case assumes the repository and MRS began operation in 2003 consistent with DOE's current plans. The I-MRS concept nominal cost exceeds DOE's NO-MRS and the I-NO-MRS concepts by about $2.0 and $3.1 billion respectively. The effects of delaying repository operation until 2008 is shown in Table I.5 assuming the I-MRS also starts operation in 2008 due to repository linkages in the 1987 NWPA Amendments and for operation in 1998 assuming the linkages are removed. For 2008 operation the nominal cost increase in the I-MRS over the I-NO-MRS would be about $3.4 billion. Allowing the I-MRS to start operation in 1998 would be reduce cost by about $1.2

TABLE I.4 - TOTAL WASTE MANAGEMENT SYSTEM LIFE CYCLE COST

REPOSITORY (& MRS) OPERATION STARTING IN 2003

COST IN MILLIONS OF 1986 DOLLARS

	AUTHORIZED SYSTEM (DOE'S NO-MRS)	IMPROVED SYSTEM (DOE'S I-MRS)	INTEGRATED CASK SYSTEM (I-NO-MRS)
TRANSPORTATION:			
DEVELOPMENT	1,080	1,080	882
FAC. & OP.	1,928	1,623	1,370
SUB TOTAL	3,008	2,703	2,252
MRS FACILITY:			
DEVELOPMENT		125	
FAC. & OP.		2,699	
SUB TOTAL	0	2,824	0
REPOSITORY:			
DEVELOPMENT	5,631	5,631	5,631
FAC. & OP.	7,000	6,000	6,700
SUB TOTAL	12,631	11,631	12,331
COMPENSATION:			
REPOSITORY	1,450	1,450	1,450
MRS		365	
SUB TOTAL	1,450	1,815	1,450
ADMINISTRATION	1,823	2,023	1,710
DOE TOTAL	18,912	20,996	17,743
AT-REACTOR STORAGE	701	560	701
SYSTEM TOTAL	19,613	21,556	18,444
SAVINGS	(1,943)	BASE	(3,112)

TABLE I.5 - COMPAIRISON OF NOMINAL AND EXPECTED TOTAL SYSTEM LIFE CYCLE COST FOR 2008 REPOSITORY OPERATION

MILLIONS OF 1986 DOLLARS

	NOMINAL COST		EXPECTED VALUE	
	AMOUNT	INCREASE	AMOUNT	INCREASE
DOE'S NO-MRS	23,150	1,236	24,777	1,239
DOE'S I-MRS(2008)	25,326	3,412	28,530	4,992
DOE'S I-MRS(1998)	24,106	2,192	26,974	3,436
I-NO-MRS	21,914	BASE	23,538	BASE

billion, however, the I-MRS concept would still cost about $2.2 more than the I-NO-MRS concept.

It is recognized that there are uncertainty in these cost estimates with more uncertainty related to I-MRS cost than at-reactor storage cost. A probabilistic cost analysis was performed to take into account these uncertainties as well as uncertainty in compensation to host states. The expected cost increase for the I-MRS concept over the I-NO-MRS concept is about $5.0 and $3.4 billion respectively for I-MRS operation In 2008 or 1998 respectively.

ENVIRONMENTAL comparison in the near-term slightly favors the I-NO-MRS due to better use of resources, but this does not appear to be a major issue. Long-term environmental concerns are related to the I-MRS becoming a defacto repository.

POLITICAL considerations are divided into ACCEPTABILITY, PUBLIC CONFIDENCE, and LOCAL AND STATE ATTITUDES. From an overall ACCEPTABILITY standpoint stakeholders closest to the public oppose the I-MRS concept. From the PUBLIC CONFIDENCE perspective the I-NO-MRS minimizes reliance on DOE and removes the possibility of political will erosion allowing the I-MRS to become a defacto repository. LOCAL ATTITUDES may be accommodating to the I-MRS due to benefits in jobs, compensation and related economic development, however, superior STATE ATTITUDES take a broader perspective that clearly favors the I-NO-MRS concept.

SOCIAL considerations are primarily related to fears and anxieties associated with transportation. This clearly favors the I-NO-MRS concept for the same reasons discussed in the HEALTH AND SAFETY evaluation.

FAIRNESS is a complex issue that is divided into LIABILITY and EQUITY considerations. The language of the NWPA clearly intended for generators of the high-level nuclear waste to be responsible for providing interim storage and paying the cost of disposal. It appears that DOE exceeded their authority under the NWPA by contracting to accept fuel in a facility they were unlikely to have available. While there is some ambiguity in this situation it appears to be a moot question. There are several EQUITY issues. From a GEOGRAPHIC perspective it is most equitable to leave fuel where the benefits were derived from its generation until it can be moved to the repository. INTERGENERATIONAL considerations require the current generation to not allow the I-MRS to become a defacto repository. INTERUTILITY equity is best server by requiring each utility to provide for their own fuel storage. UTILITY-RATEPAYER equity favors the I-NO-MRS concept since it is expected to save the ratepayers about $5 billion. GOVERNMENT-UTILITY equity favors the I-MRS since the utilities should be entitled to some at-reactor storage assistance due to the Federal Governments failure to deal with their high-level waste disposal responsibility over the past 30 years. This inequity can, however, be mitigated in less expensive and more acceptable ways in the I-NO-MRS concept. Making dual purpose cask available to utilities free of lease charges and sharing system benefits to encourage at-reactor rod consolidation would provide assistance without undermining the repository program.

SCHEDULING of disposal in a geologic repository at the earliest possible time favors the I-NO-MRS concept since it keeps the pressure on DOE, the utilities and everyone involved to get on with the repository program. The I-NO-MRS concept also avoids the distraction and diversion of resources from the repository program.

FLEXIBILITY is the ability of a system to continue to perform reliably under a wide range of conditions and uncertainties. From a TECHNICAL standpoint the I-MRS creates a bottleneck in the system making it vulnerable to failure from a wide range of causes while the I-NO-MRS provides diversity reducing the vulnerability to shutdown of the entire system. The I-MRS concept is also very fragile and difficult to define since it is too dependent on undefined interfaces with other system components. The I-NO-MRS concept is, on the other hand, very robust in that it can perform very effectively under a wide range of uncertainties independent of decisions yet to be made on geology, rod consolidation, and disposal packaging.

INSTITUTIONALLY the I-MRS is very vulnerable since there is not now and unlikely to be a strong supporting consensus necessary for effective implementation.

In conclusion it appears that here is no "need" for a I-MRS facility in the system and compared to the integrated dual purpose cask concept DOE's I-MRS concept has little or no utility.

PEER REVIEW

The February 20, 1989 draft of this report was sent to about 80 people representative of the broad range of stakeholders in the MRS issue for peer review. No comments or suggestions were received which challenges the substance or conclusions of this study. The principal criticism of the report and the authors response are briefly summarized below:

- The report is not well organized and is too long to be effective in presenting results of the study.

  RESPONSE - This is a fair criticism. The report is a compilation of the authors working papers and tends to ramble through too much detail.

- The statement that, only two of the eight evaluation criteria can be quantified is not correct. Methods are available to construct scales by which they can be quantified.

  RESPONSE - It is recognized that such scales are used in conjunction with multiattribute utility analysis (MUA) which is a valuable tool to assist in the evaluation of complex question with conflicting objectives. Objective development and use of such scales is difficult at best since the process is very subjective and are dependent on the values of the decision maker or customer. To be correct the author should have said that quantitative comparison was not practical in the circumstances of this study. Moreover, the author believes that, use of MUA through an honest broker could lead to development of a working consensus among the stakeholders defining the best waste management system configuration. The acceptance if not support by the stakeholders will be essential to timely implementation of any high level waste management system.

Time and available resources did not permit reworking or major editing of the final report which is being issued substantially in the same form as the earlier draft with the inclusion of an ADDENDUM chapter. The ADDENDUM is a critical review of DOE's current position on the MRS and DOE's MRS SYSTEMS STUDIES.

ADDENDUM SUMMARY

After Congress passed the 1987 NWPA Amendments which authorize an MRS as an integral part of the waste management system with construction and use closely linked to progress on geologic disposal DOE decided to conduct a series of studies that are called the MRS SYSTEMS STUDIES. The purpose of these studies were to assist DOE management in re-evaluation of their MRS position and to provide input to the MRS Review Commission's consideration of the need for such a MRS facility. DOE presented their MRS position and made the results of their MRS SYSTEMS STUDIES available in proceedings before the MRS Review Commission on May 25, 1989.

This study has been expanded by including an ADDENDUM CHAPTER to critique DOE's current MRS position and the MRS SYSTEMS STUDIES with emphasis on considerations related to whether or not a MRS should be an integral part of the system.

DOE reaffirmed their support for a modified MRS concept and suggested reduction in the linkages between the MRS and repository contained in the NWPA Amendments in order to realize the potential benefits of such an MRS. DOE appears to place great faith in the ability of the Negotiator, established by the NWPA Amendments, to find a willing host for the MRS and to convince the congress to reduce the MRS-repository linkages. There appears to be very little in the testimony of the various stakeholders appearing in the proceeding before the MRS Review Commission to suggest that either of these are very likely. However, DOE supports the MRS facility even if the linkages are not modified.

DOE's currently preferred MRS concept is a phased approach in which the MRS would receive, store and stage shipments of intact fuel to the repository. The MRS facilities could be expanded later to perform consolidation and disposal package preparation if found to be beneficial or necessary as the system design matures. This is an indirect acknowledgment by DOE that the waste management systems design is not mature enough to fix the system configuration, as has been indicated by others. DOE's concept for an integral MRS has been a moving target since its inception as a grand plan to remove essential operations off the critical path to getting a repository in operation.

DOE's currently preferred system configuration does not correspond to any of the options specifically analyzed in their MRS SYSTEMS STUDIES. This group of studies examine various aspects of nine waste management system configurations with and without an MRS. However, the primary focus (and usefulness) is on whether fuel should be consolidated before disposal and combinations of consolidation and final packaging functions that could be performed at the MRS or repository. The No-MRS system configuration that DOE uses in these studies is essentially the same strawman that they have used as the basis for their previous MRS justifications. DOE tries to represent this as the optimum No-MRS system configuration. Under questioning by the MRS Review Commission DOE acknowledged that they had not considered the system configuration presented and evaluated in this report for the State of Tennessee which is based on effective integration of a family of dual purpose cask into the waste management system. Incredible, DOE went on to explain that the MRS and use of dual purpose cask are separate distinct issues, which are important objectives, but don't have any impact on one another. Clearly, DOE has not adequately considered No-MRS system configurations as an alternative to the proposed MRS.

Unable to justify the proposed MRS in terms of the tradition criteria of cost, health and safety, environmental impacts, socioeconomic impacts, and transportation impacts DOE turns to what they call strategic benefits or advantages. The advantages claimed by DOE for the MRS were, facilitate of timely disposal, timely acceptance of fuel from utilities, increased confidence in the Governments ability to perform, and. to provide greater flexibility for the system to adapt to an uncertain future, reduce at-reactor impacts and to make later decisions in optimizing the waste management system. DOE feels that the decision is primarily a public policy question in which the value of the strategic benefits obtained with an MRS outweigh the increased system cost.

The strategic benefits that DOE attributes to having a MRS in the system is highly subjective. Some of the considerations can easily be turned against the MRS and others are inconsistent with the NWPA and DOE's mission. Many stakeholders would consider interim storage at a MRS facility as an indication that DOE is not effectively dealing with the problem and is prelude for allowing the MRS to become a defacto repository. DOE's justification and the MRS SYSTEMS STUDIES appear to be positioning the MRS to accommodate an extended delay in the repository program. DOE is attempting to accommodate the waste generators by providing what they could not obtain through the NWPA. That is, DOE tries to elevate waste acceptance to an equal or superior role than disposal in their mission. This is contrary to the original NWPA and subsequent amendments. DOE's cost estimates are subject to a great deal of uncertainty, which, when analyzed indicate that the net cost of having a MRS is at least twice as much as DOE's estimates.

There is nothing in DOE's reaffirmation of support for the MRS or the MRS SYSTEMS STUDIES which would change the validity or conclusions of this study for the State of Tennessee which shows that the I-No-MRS system configuration is superior to DOE's proposed system configuration. It is superior with regard to strategic considerations as well a traditional criteria and public acceptance.

II - HISTORICAL BACKGROUND

1. INTRODUCTION

The Atomic Energy Act of 1954 provided for commercial use of nuclear energy and made the Federal government responsible for high-level waste. The governments efforts to deal effectively with their own defense high-level nuclear waste as well commercial nuclear waste floundered for over 25 years prior to the passage of the Nuclear Waste Policy Act (NWPA) of 1982. This failure led to high-level waste disposal becoming a major issue by nuclear power opponents who contended that nuclear power plants should not be allowed to operate until a satisfactory solution to high-level waste disposal is available. To understand the issues and implications related to building and operating a monitored retrievable storage (MRS) facility as part of the governments commercial nuclear waste management system it is useful to review some of the major milestones that were instrumental in shaping the NWPA of 1982.

o In 1957 the National Academy of Sciences concluded that radioactive waste can be disposed of safely in a variety of ways and that disposal in a deep salt formation was the most promising for the near future. They recommended that the necessary geologic investigations be conducted and the disposal means be established prior to authorization of construction of civilian nuclear power plants.

- In 1959 Congress concluded that radioactive waste management practices had not resulted in any harmful effects on the public and there was no need to delay the development of the nuclear energy industry. The government proceeded with the commercial development of nuclear power and initiated a modest waste disposal program which led to the decision in 1970 to build a repository in salt deposits near Lyons, Kansas.

- From the inception of commercial nuclear power it was assumed that spent nuclear fuel would be chemically reprocessed to recover plutonium and residual uranium as valuable energy resources. The plan was to recycle these materials back to the current generation of nuclear power plants then eventually to breeder reactors that could increase the effectiveness of uranium resource utilization by a factor of about fifty.

- In 1970 Federal regulations defined high-level waste to be reprocessing plant liquid waste which was to be converted to a suitable solid form within 5 years and then transferred to a Federal repository within another five years.

- The Lyons repository project was abandoned in 1972 due to technical, political and public acceptance problems. The government then proposed to build a Retrievable Surface Storage Facility (RSSF) at a federal site in the west to provide dry vault storage of high-level nuclear waste until a geologic repository was available. This is one type of monitored retrievable storage (MRS) facility that has many functional similarities to DOE's current MRS proposal. The proposal was withdrawn in 1975 due to opposition from the public, Western Governors, and the Environmental Protection Agency.

- In 1976 a comprehensive assessment of technologies for managing nuclear waste was completed without reaching any policy conclusions.

- President Carter announced in 1977 that spent nuclear fuel will not be reprocessed and proposed that the government accept spent fuel from utilities upon payment of a one-time fee to pay for government provided away-from-reactor (AFR) storage and geologic disposal. Several options for providing retrievable storage at existing commercial (GE's Morris plant and the AGNS Barnwell plant) and Federal facilities as well a building a central AFR at

Oak Ridge was explored but could not obtain sufficient Congressional support for implementation. This was a MRS facility in another form that has been considered and rejected.

- o In the mid 1970's TVA and other utilities started increasing capacity of at-reactor spent fuel storage pools and TVA initiated studies to examine a wide range of alternatives for providing indefinite at-reactor spent fuel storage. This is a limited form of decentralized monitored retrievable storage.

- o In 1979 a comprehensive study of centralized and decentralized storage concepts was completed by the Tennessee Valley Authority (TVA) resulting in a policy decision to provide for life of plant storage at each nuclear plant since it did not appear prudent to rely on the government accepting spent fuel for disposal within the foreseeable future. To meet storage needs that could not be accommodated in existing reactor pools the nominal plan was to build additional pool facilities at each plant since this was the only proven technology available. An ambitious program was also undertaken to develop and demonstrate improved technologies for increasing pool capacity and providing additional facilities using dry storage technology.

- In 1980 President Carter accepted an inter-agency review group recommendation to proceed with geologic disposal based on extensive characterization of 4 or 5 sites in a variety of environments before submitting a license application for one of them to the Nuclear Regulatory Commission (NRC).

- In 1981 President Reagan removed the prohibition on reprocessing spent fuel and abandoned the Carter Administrations efforts to provide a federal AFR facility. The decline of the nuclear option was well underway at that time and reprocessing spent fuel was not a viable alternative for nuclear utilities leaving then to provide for their own interim at-reactor storage of spent fuel.

2. THE NUCLEAR WASTE POLICY ACT DEBATE

The central issue in the Congressional debate preceding passage of the Nuclear Waste Policy Act (NWPA) of 1982 was whether isolation of high-level waste should be by storage or disposal. Three options were considered:

1. Commit immediately to mined geologic disposal as the best understood disposal technology.
2. Defer the decision on disposal technology for 50 years or more and provide centralized Federal storage until research and development can be conducted on a number of disposal technologies and a final choice made for full scale disposal.

3. Develop a permanent monitored retrievable storage (MRS) system that preserves the option to reprocess fuel or to use a better disposal technology if one is developed.

For the foreseeable future there would be little difference between options 2 and 3. The principal arguments favoring MRS were flexibility and cost. The arguments against MRS were:

- o leaving the problem to future generations,

- o removing pressure to develop a disposal system because of the availability of Federal storage, and,

- o creating the impression that the problem cannot be solved thereby heightening public concern.

After an extended debate Congress chose option 1 (proceeding with geologic disposal), which became the context in which the NWPA was formulated. In a compromise with the MRS proponents Congress did recognize the potential usefulness of MRS as a backup option in case serious problems arose in the geologic repository program.

Monitored retrievable storage of spent fuel can take many different forms. The storage of fuel in water pools at the reactor or at central facility is a form of interim monitored retrievable storage that is widely used in the United States and abroad. In this application water provides both shielding and cooling which requires active maintenance of the water systems. The MRS concept considered in the Congressional debate was different in that it would provide perpetual storage instead of disposal. Similar storage methods can also be used at reactor sites to provide decentralized interim monitored retrievable storage for several decades or perhaps as long as a hundred years. A central MRS facility would, however, be more appropriate for maintaining administrative control if the intent is to utilize monitored retrievable storage for hundreds of years or longer. The fundamental difference between a perpetual MRS and geologic disposal is that disposal undertakes to eliminate the need for long term administrative control.

In 1981 DOE completed, at request of Congress, a review of the status of the MRS concept and analysis of its impact on the waste management system. DOE examined several MRS concepts that used hermetically sealed containers placed in passively cooled dry storage to prevent the release of radioactive materials which should be capable of both safe containment "for the foreseeable future" and ready retrievability. The concepts evaluated can be categorized as follows:

1. Storage in holes drilled into the ground either in an open field or in a tunnel, referred to a "dry wells".

Shielding is provided by the ground, and cooling is provided by conduction through the ground to the atmosphere.

2. Surface storage in concrete structures or casks. The structure provides the shielding, and cooling to the atmosphere is provided by conduction and/or convection.
3. Storage in air inside tunnels (referred to as the "tunnel-rack" concept). Shielding is provided by the ground, and cooling to the atmosphere is provided by natural draft.

In their analysis DOE identified the following three potential roles for a MRS facility:

1. Storage of spent fuel or high-level waste before disposal in a geologic repository.
2. Interim storage of spent fuel before reprocessing.
3. Permanent storage of spent fuel or high-level waste.

From a traditional engineering economic (present worth of cost) point of view DOE concluded that permanent storage in a MRS with replacement ever 100 years is preferred over geologic disposal. DOE indicated that such a MRS role requires that a commitment be made for institutional control of the facility and subjects the waste to safety risk from both natural and man-induced events should institutional control be lost. DOE also reminded the Congress that the public's position on the acceptability of monitored retrievable storage (MRS) was made clear in the early 1970's when it was necessary to abandon the Retrievable Surface Storage Facility (RSSF) that had been proposed.

The geologic disposal concept adopted in the United States is founded on a system of multiple, relatively independent barriers designed to ensure that the toxic radionuclides remain isolated from man and his environment at least until they have decayed to levels which will present no unacceptable risk to future generations taking into account possible release scenarios. The barriers considered are:

1. the waste form,

2. the canister in which the waste is placed,

3. backfill and additives placed around the canister in the repository, and,

4. the natural geochemical environment in the repository.

The difficulty is predicting, with a high degree of confidence, how the disposal system will perform under the conditions to which it might be subjected over the very long periods of time involved. In the case of reprocessing waste the time frame required is in the order of a thousand years and for spent fuel rods in the order of a million years. The presence of higher concentrations of plutonium and other long life transuranic elements in spent fuel account for the longer time required for spent fuel.

It is difficult, at best, to scientifically demonstrate in legal proceedings the performance of a disposal system over these time periods due to the many uncertainties involved. The nature of science is better at raising questions than it is at answering them. Generally, the more we learn, the more we find that we don't know. It appears that the current approach to geologic disposal is the result of an incompatible marriage between science and politics which could result in an extended delay in licensing a geologic repository. It may not be practical to scientifically prove that the high standards set for disposal can be achieved necessitating a change in program direction to some form of perpetual MRS facility. Such MRS facility could located in a deep geologic formation similar to a geologic disposal repository. The principal difference is the underlying philosophy of perpetually maintaining the facility with the ability to take any remedial action that might be needed including recovery of the waste rather if that should be necessary than relying on the geologic setting to provide permanent isolation. This would be similar to the "tunnel-rack" concept studied by DOE in 1981 but could be greatly improved through the use of the "universal cask" concept which uses the same container for at-reactor storage, transportation, and as a self shielding disposal container in the repository.

3. THE NWPA AND THE MRS

The NWPA was passed in the closing hours of the Congress in late 1982. It did not authorize a MRS, but, directed the Department of Energy (DOE) to perform a detailed study of the need for and the feasibility of one or more MRS facilities and to submit a proposal to build one ore more MRS facilities to Congress by June, 1985. As defined in Section 141 of the NWPA, the MRS facilities shall be designed to the following criteria:

- o To accommodate civilian nuclear high-level (reprocessing plant) waste and spent fuel,
- o To permit continuous monitoring and management for the foreseeable future,
- o To provide for ready retrieval for further processing or disposal, and,
- o To safely store spent fuel and high-level waste as long as necessary by maintaining such facility through appropriate means including replacement.

The proposal was to include:

- o A Federal program for siting, development, construction, and operation,

- o A plan for funding which shall provide for the cost to paid by generators or owners of the waste and spent fuel stored at the facility,

- o Site-specific designs, specifications, and cost estimates sufficient to support congressional authorizations and implementation as soon as practical, and

- o A plan for integrating the MRS with other storage and disposal facilities authorized in the NWPA.

The NWPA also:

- o Requires that any MRS be licensed by the Nuclear Regulatory Commission (NRC),

- o Exempts states approved for repository site characterization from hosting an MRS,

- o Exempts DOE from preparing an Environmental Impact Statement to support submitting the MRS proposal to Congress,

- o Requires DOE to describe research and development considered necessary to develop the MRS proposal,

- o Requires DOE to consider at least three alternative sites and a least five combinations of sites and facility designs in arriving at DOE's preference,

- Requires DOE to prepare and submit with the proposal an Environmental Assessment which shall include an analysis of the five alternative combinations based on available information regarding alternative technologies,

- Exempts any Environmental Impact Statement that may be required under the National Environmental Policy Act of 1969 from considering the need for an MRS or any alternative to the design criteria in the NWPA,

- Authorizes, subject to appropriations, impact assistance to general local government to mitigate any social or economic impacts related only to planning, construction, maintenance, and provision of public services related to MRS siting, and

- Extends the consultation and cooperation provisions, including state veto subject to Congressional override, of the NWPA related to geologic repository states to MRS states.

The MRS study provisions were included in the NWPA after the geologic disposal approach was selected and nuclear utility industry leadership was not successful in getting a Federal AFR financed out of the Nuclear Waste Fund established by the NWPA. This placed the responsibility of providing interim storage of spent fuel on the spent fuel owners until such time as DOE accepts the fuel for disposal. To assure that no utility would be forced to shut down a nuclear plant for the lack of spent fuel storage the NWPA does provide for Federal Interim Storage (FIS) up to the equivalent of 1,900 metric tons of spent fuel. The individual utilities that choose to take advantage of this service must pay the full cost and obtain NRC certificate that they are unable to provide their own storage. To date, no utility as expressed any interest in taking advantage of this option.

4. TVA's EVALUATION OF AT-REACTOR STORAGE OPTIONS

By late 1983 TVA had completed conceptual design studies of various dry storage concepts and had entered into a cooperative program with the DOE to demonstrate rod consolidation and dry cask storage at the Browns Ferry Nuclear Plant. Results of these studies showed that TVA could forgo building additional storage pools when the practicality and licensablity of these technologies were demonstrated. The combination of these technologies would permit TVA to provide at-reactor storage indefinitely or as long as may be necessary without relying on DOE to accept the fuel for storage or disposal. The acceptability and economics of this form of decentralized interim monitored retrievable storage depends on it how well it is integrated into the overall waste management system. These findings were reviewed with TVA's Board of Directors in 1983 leading to a reaffirming of the decision to be prepared to take care of our own fuel indefinitely and direction to promote development of these technologies and their integration into the overall waste management system.

TVA did not have a near term need for additional fuel storage capacity and efforts were being made to reduce the Office of Power budget. Rather than directly sponsor this work the strategy adopted was to get others to do demonstrations and encourage DOE to integrate the technology into the overall system. The Browns Ferry demonstration projects were not completed as planned, but, did contribute significantly to preparations for successful demonstrations by others. TVA's efforts in promoting systems integration also had some degree of success in influencing the thinking at DOE, the Electric Power Research Institute (EPRI) and other stakeholders. These efforts were instrumental in shaping attitudes and consideration of the possibilities available for integrating at-reactor storage into the overall waste management system.

5. EVOLUTION OF DOE'S MRS PROPOSAL

The Congressional debate and criteria in the NWPA pertains to the MRS as an alternative to disposal rather than interim spent fuel storage. As has been previously noted, any form of interim storage either at a nuclear plant or at a central facility can be technically classified as monitored retrievable storage. The NWPA allows DOE to define the MRS function in the overall waste management system.

DOE's draft Mission Plan for the Civilian Radioactive Waste Management Program was issued for comment in April of 1984. It describes MRS as an option for only providing interim buffer storage if there is a serious delay in the repository. For shorter delays no MRS facility would be built and DOE would provide any Federal at-reactor-storage that might be needed starting in 1998 when disposal was to began. DOE was, at that time, considering the following options for providing Federal at-reactor-storage:

- o dual purpose casks suitable for storage and transportation,

- o universal casks that could also serve as the geologic disposal container as well as being suitable for storage and transportation, and

- o sealed fuel containers that can be used for at-reactor storage then shipped in a transport cask to the repository for disposal without removing the fuel.

In early 1984, it was clear that DOE viewed a MRS facility as a last resort. These concepts were based on integrated systems studies being performed for DOE by a team made up of TVA, Westinghouse and Florida Power and Light.

In the spring of 1984 Bernard Rusche became the first permanent director of DOE's Civilian Radioactive Waste Management (OCRWM) Office. In his confirmation hearing he made a personal commitment to began accepting fuel from utilities by 1998 and indicated that he had a different role in mind for the MRS. By the end of 1984 DOE's internal program were being redirected to support the concept of a MRS as an integral part of the waste management system. The primary function of the MRS in this concept was to serve as a centralized packaging facility with interim storage as a secondary function. Initially the intent was to ship all spent fuel from the reactors to the MRS where it would be disassembled and consolidated into canisters as a repository ready package eliminating all fuel preparation activities at the repository. The package would then be shipped to the repository by dedicated train or placed in interim storage in concrete cask until the repository is ready.

This concept was modified to provide for intermediate packaging at the MRS and addition of a disposal overpack at the repository since there was not a standard disposal package design for the various geologic disposal media under consideration. It was also decided to ship western fuel directly to the repository where it would be packaged for disposal. These modifications undermine many of the potential advantage of the original packaging facility concept since it does not eliminate fuel packaging operations at the repository. This, however, does make it possible and perhaps desirable to ship some fuel directly to the repository rather than going through the MRS facility. If use of the MRS is made optional then many utilities would elect to ship their fuel directly to the repository especially if they can avoid having to pay for MRS use. This would not functional change the MRS concept proposed by DOE and only changes the scale of operations at the MRS and repository.

6. DOE'S I-MRS CONCEPT

DOE would accept title to spent fuel that has cooled for at least five years at the reactor site after it has been loaded by the utility into shipping cask provided by DOE. Single cask shipments would be made to the MRS facility by rail or truck in general commerce as appropriate to transport access and nuclear plant cask handling capability. About 70 percent of the fuel would be shipped by rail and 30 percent by truck using a improved fleet of cask being developed by DOE. About 10 percent of the fuel would be shipped directly to the repository.

On receipt at the MRS facility, fuel would be unloaded in a dry hot-cell environment and placed in temporary dry vault storage. Intact fuel assemblies would be removed from storage and transferred to hot-cells where automated remote control equipment behind thick concrete walls would remove the fuel pins from their assembly and consolidate them into sealed stainless steel canisters of uniform size and place them in temporary dry vault storage. An inert cover gas would be used in the canisters to assure that there is no significant degradation of the fuel in storage.

Consolidation of fuel rods permits up to twice as much fuel to be paced in a container reducing subsequent storage, handling, and disposal cost. Non-fuel bearing scrap from the consolidation operations would be compacted and similarly packaged for storage and shipment to the repository. The MRS would also have the capacity to encapsulate fuel into disposal containers if this step proves to be more efficient than encapsulation at the repository.

Canisters of consolidated fuel would be removed from dry vault storage for shipment to the repository or for interim storage at the MRS facility in large metal lined reinforced concrete cask. These portable storage cask weighing up to 220 tons would be manufactured at the MRS site. These casks would be about 12 feet in diameter and range from 17 to 22 feet in height. The fuel canisters would be mechanically sealed in these cask which would be placed on concrete pads in a large storage yard within a fenced security area where the cask would be monitored. When the fuel is to be shipped to the repository storage cask would be moved back to the dry storage vault and the fuel canisters would be transferred to large transport cask. Several transportation cask would moved in the same shipment by dedicated train to the repository.

Since this MRS concept would operate as an integral part of the waste management system DOE proposes to finance it out of the Nuclear Waste Fund. This requires all waste generators to pay for the facility without regard to the extent of their use.

DOE originally planed on starting to accept fuel for shipment to the MRS in 1996 based on an initial repository operation in 1998 as specified in the NWPA. When DOE officially delayed initial repository operation five years to 2003 the start of MRS operation was deferred to 1998.

DOE identified a broad region in the central portion of the eastern part of the country for locating the MRS to minimize transportation impacts. After evaluation of a number of potential sites DOE selected three sites in Tennessee naming the Clinch Breeder Reactor site in Oak Ridge as the preferred site. The other sites were the Exxon Reprocessing Plant site also in Oak Ridge and TVA's Hartsville Nuclear Plant site near Nashville.

In making their proposal DOE acknowledged that the waste management system could be operated without a MRS facility and it would increase the overall cost of the system. However, DOE believed that the value of system operating flexibility and reduction in transportation and utility storage cost more than offset the additional cost. By emphasizing system integration in optimumization of the overall waste management system with the proposed MRS DOE has concluded that important program objectives can be enhanced. The improvements include:

- Improved transportation efficiency because consolidation and packaging at the MRS would reduce the number of shipments to the repository with concomitant reductions in potential environmental impacts and risk to the public.

- Increased reliability and flexibility in operating the system in an integrated cost-effective manner by incorporating the MRS which can regulate the flow of waste to the repository.

- Improved confidence in beginning to accept quantities of waste no later than January 31, 1998.

- Ability to accept significantly larger quantities of waste earlier, substantially reducing the added cost to utilities of providing increased at-reactor storage.

- o Ability to focus repository licensing efforts on demonstrating the long-term isolation capability of the repository site because many of the operational functions (i.e., waste preparation) would be handled at the MRS.

7. RESPONSE TO DOE'S MRS PROPOSAL

Because of the long and controversial history of nuclear waste management the implications of monitored retrievable storage is perceived quite differently by many people. The merits of the MRS proposal depends largely on what an individual considers important and their values.

Some anti-nuclear proponents and public interest groups see the MRS proposal as acknowledgment that the problem of geologic waste disposal is not solvable and is the first step towards perpetual storage of nuclear waste. Once the utilities are allowed to transfer the fuel to the government and it is in interim storage at a central location the pressure will be off to aggressively pursue implementation of geologic storage. The economics of nuclear waste management favor perpetual storage rather than disposal. They see the proposed MRS as an effort to undermine the commitment made in formulating the NWPA to proceed with geologic disposal as the final solution. Some see it as a covert effort to resurrect spent fuel reprocessing and others think it to just be a bad ideal. There appears to be very little support for the MRS among public interest and environmental groups.

The initial reaction to the proposed MRS by the nuclear utility industry was mixed as indicated by a survey conducted by the Congressional General Accounting Office (GAO). The majority of utilities responding indicated that they would prefer to provide for their own interim storage rather than pay for storage at an MRS. However, an organization of utility industry executives called ACORD was instrumental in obtaining endorsements of the MRS from nuclear industry trade associations and have undertaken to present a united nuclear industry front in support of the MRS. Various arguments have been advanced in support of this position beyond those cited by DOE. Among them are:

- It is important to show tangible results to the public, in terms of brick an mortar, that the nuclear waste management problem is being solved.

- Utilities and their rate payers should have something to show for the billions of dollars being paid into the Nuclear Waste Fund.

- The Federal government will not move expediently to proceed with geologic disposal until they have possession of the spent fuel and are forced to do something.

Upon proposing to locate the MRS in Tennessee DOE arranged to finance independent reviews of their MRS proposal by the State of Tennessee and the local communities in which the facility would be located. The Hartsville community concluded that they wanted nothing to do with the MRS due to the poor experience they had when TVA cancelled the Hartsville Nuclear Plant. The Oak Ridge community, which has relied primarily on government nuclear related programs, undertook a broad based assessment of the proposed MRS. They did not address the questions of need or technical feasibility of such a facility but focused primarily on the impacts of the facility on the community. They concluded that the MRS would be acceptable in the community provided that:

- Use of the MRS for spent fuel storage be linked to NRC issuance of a geologic repository construction permit and limiting the amount of fuel that could be stored at the MRS to prevent the MRS from becoming a defacto permanent repository for spent fuel.

- Payments be made to local governments equivalent to property tax in addition to the usual impact mitigation payments.

- Local control over MRS operation with the authority to suspend operation if they felt it was justified.

Since the Oak Ridge community has a long record in dealing with and distrust of the Federal government they insisted that these provisions be written into the law authorizing the MRS. The nuclear utility industry through ACORD commended the Oak Ridge community for their work and indicated that they would support inclusion of the proposed linkages in any legislation authorizing the proposed MRS. DOE recommended to congress acceptance of constraints on MRS use, acceptance in principal of payments comparable to property tax, and local representation on a committee that would oversee MRS operation and could make recommendations to DOE.

The state of Tennessee undertook a comprehensive assessment of DOE's MRS proposal as input to the Governor in deciding what position he should take. The states study committee was supported by a team of contractors and a technical advisory panel of experts. A careful independent review of the need, feasibility and cost of the proposed MRS was conducted. The state found itself studying a moving target. When inflated claims of both transportation benefits and on-site storage benefits were uncovered DOE switched the emphasis in their justification to greater flexibility and the demonstration of progress in solving institutional and logistic problems. The states assessment showed that the MRS could operate safely, provided that sufficient care and quality control are exercised by DOE. The risk of transporting spent fuel by rail or on the highways were shown to be small. The only serious question raised regarding feasibility was related to performing rod consolidation in hot-cells at the MRS. There was not a clear justification of the benefits of rod consolidation for disposal. This operation was seen to have the greatest potential to generate accidents, unforeseen personnel exposure, overuns in cost, and production of low level waste. The state found that the rod consolidation and storage functions of the MRS can be performed at the individual reactor sites. The State of Tennessee found the MRS to be an unnecessary expensive and the estimated cost are likely to increase substantially if implemented. The State of Tennessee also concluded that a better and cheaper solution than the proposed MRS can be readily designed for meeting legitimate needs of the nations nuclear waste management system. The State of Tennessee suggested that DOE should develop an improved transportation system and provide incentives to utilities to provide at-reactor storage through rod consolidation and dry cask storage.

The socioeconomic studies conducted for the State of Tennessee indicated that the MRS would have and adverse impact on business development and tourism in the area. Public support was slightly in favor of the MRS in the Oak Ridge vicinity, however, across the state there was about twenty to one opposition to the MRS. The Governor decided to oppose the MRS and vowed to exercise this veto power. In making his announcement he stressed that the MRS is not needed and Oak Ridge would be the wrong place for a MRS. The State Legislature conducted its own investigation and voted overwhelmingly to reject the MRS proposal.

The state of Tennessee had no prior warning when DOE proposed to build the MRS in Tennessee. The state felt that DOE should have conferred with them during the site selection process as provided for repository states in the NWPA. The state obtained a Federal Court restraining order enjoined DOE from submitting their Proposal to Congress. The restraining order was eventually overturned after delaying the submission for over a year. The MRS fight then moved to the Congress. There was strong support for the MRS in the Senate but strong opposition in the House. This led to a stalemate since the House blocked efforts to authorize or provide any funds for the MRS.

8. NWPA IMPLEMENTATION

The NWPA required geologic disposal to began by January 1998 and prescribed a number of milestone dates for siting and licensing the repository to meet this ambitious schedule. This date was intentionally chosen to be optimistic in hopes of providing motivation. The NWPA required DOE to enter into written consultation and cooperation agreements with affected state and Indian tribes and gave a state selected for the repository a veto right subject to override by a joint resolution of both houses of Congress. Congress intended for DOE establish an open and cooperative partnership with the states to obtain public acceptance if not support of an acceptable repository site. The NWPA also placed all civilian nuclear waste facilities to be managed by DOE under the regulatory jurisdiction of NRC.

Management of the civilian high-level nuclear waste program was, clearly, not to be business in the usual manner of management of defense programs not subject to the scrutiny, regulation and litigation inherent in the NWPA. By necessity, DOE established a success oriented schedule that allowed little flexibility in meeting the NWPA project milestones. Most observers, that were aware of the complexities involved, believed that at least an additional ten years would be required to get the first repository in operation. DOE's efforts to expedite meeting their schedule created friction with the affected states which felt that DOE was more interested in meeting the schedule than they were in the technical quality of the work. This resulted in affected states resorting to use of the courts to bog the program down in litigation. DOE was not successful in getting any state to enter into a consultation a cooperation agreement as required by the NWPA. Politically, however, the states had no real incentive to cooperate with DOE. Most of their constituency might interrupt such cooperation as encouraging location of the repository in their state. DOE's management style in the program bureaucracy and obscure processes in making and justifying their decisions did not instill the trust and confidence necessary for the success of a program of this type. In fact, an Alternative Means of Financing and Management (AMFM) Panel, commissioned by the NWPA, recommended that the program be taken out of DOE and places in a newly created independent government/private organization. This recommendation, however, was not seriously considered since it would have required reopening the NWPA for amendment and would result in a major disruption in the program.

By the beginning of 1987 the program had become hopelessly bogged down. In five years, DOE had delayed the repository five years to 2003 and managed to make waste disposal a more sensitive high profile issue. It appeared that the fragile coalition that made the NWPA possible had unraveled. While the general situation as previously described was a contributor the most immediate cause was the way DOE selected three sites for detail characterization and deferral of the second repository program. It was not that either of these were poor decisions. The problem was the appearances created by the way DOE went about them creating a loss of confidence in their credibility. These were:

- o DOE originally propose the use of three methods for ranking potential sites as a basis for selecting three for detailed characterization. The affected state found none of these methods acceptable. In response DOE proposed to use multiattribute utility analysis for weighing conflicting considerations as an aid in the decision making process. The method utilizes subjective opinions of technical experts but should be less subject to manipulation. The use of this methodology was reviewed, at DOE's request, by a committee of the National Academe of Sciences which approved its use, if applied properly and suggested that DOE provide for participation by experts other than DOE's. DOE declined to use outside experts but did do a reasonably objective job of implementing the methodology at a technical level. However, DOE's top management elected to use criteria not explicitly considered in the methodology to make their final choice resulting in their previous preferred choice of three sites which conflicted substantially with the results of the multiattribute utility analysis. Those who did not agree with DOE's choice, accused DOE management of "cooking the books". DOE said that the method was only intended to provide input to their decision.

o While not explicitly included in the NWPA there was an understanding that there was to be a east-west balance in siting repositories. The first repository was to be in the west and the second was to be located in the east in crystalline rock. With this in mind the NWPA placed a disposal limit of 70 thousand metric tons of spent fuel on the first repository (In 1982 DOE estimated that disposal capacity for 140 thousand metric tons of spent fuel would be needed by 2020). DOE initiated a screening process in cooperation with affected states to identify those crystalline rock sites in the east that warranted further investigation. The announcement of 14 potential sites caused much political turmoil in the states selected and concern in their congressional delegations. Just before the 1986 Congressional elections DOE suspended the second repository program indefinitely without prior consultation with the Congress. The circumstances and some evidence suggest that this action was taken in response to pressure from the White House to take action that would help some candidates. DOE denied this and contended that the deferral was due to more realistic forecast of spent fuel disposal needs indicating that there would be plenty of time to restart the second repository process when there was a need (An independent probabilistic study by TVA indicated in 1985 that the expected spent fuel disposal requirements for reactors operating and likely to be completed was less than the 70 metrics tons authorized for the first repository). While eastern states were pleased by DOE's action western states wanted to restart the site selection process for the first repository and to include crystalline rock sites.

Congress cutoff funds to allow DOE to do any below-ground site characterization work at the three sites DOE had selected and blocked authorization of the proposed MRS. Congress was not eager to take up the contentious nuclear waste issue before the 1988 elections. It appeared that the program would be in limbo for several years until after a new Administration was in office and was ready to address the issue. However, Senator Jhonson (D-La), who has been a strong supporter of the nuclear industry and the principal congressional proponent of the MRS as an alternative to disposal, succeeded in attaching amendments to the 1987 Budget Reconciliation Act as a cost cutting action which avoided full debate on the nuclear waste issue. The major provisions of this legislation would:

- o Provide for characterization of a single site to be chosen by DOE saving about two billion dollars over characterizing three sites as provided in the NWPA,

- o Authorize the MRS as an integral part of the waste management system, but without the restrictions suggested by Oak Ridge and proposed by DOE, and

- o Provide incentives of $100 million and $50 million per year to states willing to host a geologic repository and MRS respectively.

Companion legislation was not available in the House of Representatives which had been moving towards a study commission to consider restructuring the program and the use of a negotiator to work with the states in selecting a repository site. After several unsuccessful attempts at reaching an agreement in conference it appeared that there would be no nuclear waste legislation in 1987 and the program would continue to flounder. At the last minute, the House Leadership offered an acceptable compromise with the following principal features:

- o Specified the Yucca Mountain site in Nevada as the repository site,

- o Authorized the MRS with restrictions on its use and deferred proceeding until a report is provided by a special commission created to address the need for an MRS,

- o Reduced the incentive payments to host states, by a factor of five, to \$20 million and \$10 million per year for the repository and MRS respectively, and

- o Adopted the concept of a negotiator to work out acceptable arrangements with host states.

This legislation avoided open debate on nuclear waste issues and was not satisfying to some of the stakeholders. It did, however, provide a new lease on life for the program which should allow it to proceed in the chosen direction for several years. The best chance for success in this new direction probably depends on the skill and wisdom of the negotiator. After a year an appointment for this important position has not been made.

9. NWPA 1987 AMENDMENTS AND THE MRS

The 1987 amendments to the Nuclear Waste Policy Act (NWPA) of 1982 annulled and revoked DOE's proposal to build a MRS in Tennessee and authorized DOE to site, construct and operate one MRS facility subject to the following conditions:

- o Site selection may not begin until a MRS Review Commission reports to the Congress by June 1, 1989 on the need for a MRS facility,

- o No MRS may be located in Nevada,

- o Construction may not begin until NRC issues a license for constriction of a repository,

- o The quantity of nuclear waste stored at the MRS may not exceed 10,000 metric tons until the repository begins accepting waste,

- o The quaintly of nuclear storage may not exceed 15,000 metric tons, and

- MRS construction or acceptance of nuclear waste shall be prohibited during any time a repository license is revoked by the NRC or construction of the repository ceases.

A three member commission is established for the purpose of reporting to the Congress by June 1, 1989 on the need for a MRS facility as a part of the Nation's nuclear waste management system that achieves the purposes of the NWPA. In preparing their report the MRS Commission shall:

- Review the status and adequacy of DOE's evaluation of the systems advantages and disadvantages of bringing such a facility into the national nuclear waste disposal system,

- Obtain comment and available data on monitored retrievable storage from affected party, including States containing potentially acceptable sites,

- Evaluate the utility of a MRS facility from a technical perspective,

- Make a recommendation to Congress as to whether such a facility should be included in the national nuclear waste management system in or to achieve the purposes of the

Act, including meeting needs for packaging and handling spent nuclear fuel, improving the flexibility of the repository development scheduled, and providing temporary storage of spent fuel accepted for disposal.

In preparing the report and making its recommendations the MRS Commission is required to compare the MRS facility to the alternative of at-reactor storage. This comparison is to take into consideration the impact on:

- o repository design and construction,
- o waste package design, fabrication and standardization,
- o waste preparation,
- o waste transportation systems,
- o reliability of the national disposal system,
- o ability to fulfill contractual commitments to accept fuel for disposal, and
- o economic factors, including the impact on the cost to be imposed on ratepayers for temporary at-reactor storage as well as cost likely to be imposed due to the building and operation

of a MRS facility.

The MRS Commission has been appointed and was officially commissioned in June after a six month delay. This delay was due largely to political wrangling over the appointments. The time the MRS Commission has to complete its work has been extended to November 1, 1989.

After the MRS Commission submits its report to the Congress DOE may conduct a survey and evaluation of potentially suitable MRS facility sites. The MRS site, however, can not be selected until the DOE Secretary recommends to the President the approval of a site for development as a repository. An environmental assessment, based upon available information, is to submitted to the congress at the time the MRS site is selected. In conducting the survey and evaluation DOE is to consider the extent to which siting a MRS facility at each site surveyed would:

1. enhance the reliability and flexibility of the waste disposal system,

2. minimize the impacts of transportation and handling of such fuel and waste,

3. provide for public confidence in the ability of the such system to safely dispose of spent fuel and waste,

4. impose minimal adverse effects on the local community and local environment,

5. provide a high probability that the MRS facility will meet applicable environmental, health, and safety requirements in a timely fashion,

6. provide such other benefits to the system as the Secretary deems appropriate, and

7. unduly burden a State in which significant volumes of high-level radioactive waste resulting from atomic energy defense activities is stored.

At least six months before selecting a MRS site the Secretary must notify the Governor and legislature of the State in which the site is located, or the governing body of the affected Indian tribe, as the case may be, of such potential selection and the basis for such selection. The State or Indian tribe can submit a notice of disapproval of such site with 60 days of site selection. The selection of the site will not be effective unless both house of the Congress override the State disapproval.

Once selection of the MRS site is made by the Secretary the State or Indian tribe is eligible to enter into a benefits agreement with DOE. The benefits agreement provides for annual payments of $5 million and $10 million respectively for a MRS or repository until receipt of waste. These are increased to $10 million and $20 million annually respectively from receipt of waste until the closure of the facility. States or Indian tribes entering in such agreements must wave their rights to site disapproval and impact assistance. The agreement is to provide for participation in a Review Panel to advise the Secretary on matters relating to design, construction, operation, and decommissioning of the facility.

The 1987 NWPA Amendments establishes the Office of the Nuclear Waste Negotiator. The Negotiator is to attempt to find a State or Indian tribe willing to host a repository or MRS facility at a technically qualified site on reasonable terms and conditions. Any proposed agreement is to be submitted to the Congress and shall have no effect unless enacted into Federal law.

The 1987 NWPA Amendments direct DOE to conduct a study and evaluation of the use of dry cask storage technology at the sites of civilian nuclear power reactors for the temporary storage of spent fuel until such time as a permanent geologic repository has been constructed and licensed by NRC. In conducting the study the Secretary shall:

1. consider the cost of dry cask storage technology, the extent to which dry cask storage will affect human health

and the environment, the extent to which at-reactor storage affects cost and risk of transporting spent fuel to a central facility, and any other factors the Secretary considers appropriate,

2. consider the extent to which the Nuclear Waste Fund can be used to construct, operate, maintain and safeguard fuel in at-reactor dry cask storage,

3. consult with the NRC and include their views in the report, and

4. solicit the views of State and local governments and the public.

The results of the study is to be submitted to the Congress by October, 1, 1988. An initial version of the report was issued, for comment, in August 1988.

III - THE SYSTEMS APPROACH

A "system" is an orderly arrangement of components according to some rational principal which interact for a purpose. The high-level nuclear waste management system is made up of several major components which are themselves interrelated systems working towards a common objective. These can be broken down into smaller components or sub-systems in a hierarchical structure. Each component or sub-system has an effect on the other components and the behavior of the system as a whole. Once the purpose of a system has been explicitly defined and understood it is possible to establish measures of effectiveness indicating how well the overall system performs in the systems environment in which it is intended to function

1. WHY A SYSTEMS APPROACH?

The high-level nuclear waste management system, as a minimum, consist of three major components: at-reactor storage, spent fuel transportation, and a repository. Each of these is a complex system that must be integrated into an effective overall system. The inclusion of a monitored retrievable storage (MRS) facility as an integral part of the waste management system adds a fourth major component to the system. The potential functions that could be performed in whole or in part at a MRS facility are:

- interim storage of spent fuel until it can be shipped to the repository for disposal,

- processing of the fuel in preparation for disposal which might include inspection, classification and consolidation of fuel rods into a lower volume configuration,

- packaging the fuel in a repository ready disposal package or in an intermediate package for interim storage which would be placed in a disposal over-pack at the repository for disposal, and

- serve as hub for spent fuel transportation activities between the reactors and the repository.

The current MRS concept being pursued by DOE is based on consolidation of fuel rods prior to disposal in a geologic repository. However, rod consolidation has not been shown to be cost effective in terms of disposal benefits in the repository, but might have some advantages for storage and transportation when performed at the reactor sites or at a MRS facility. The effectiveness and reliability of the large scale highly automated remote control dry rod consolidation process proposed by DOE for use at the MRS or at the repository is yet to be developed and demonstrated. This process represents the greatest technical uncertainty outside the repository in preparing fuel for disposal and represents is a source for producing additional volumes of waste and potential operating accidents.

Most of the MRS packaging functions would be performed at the repository in a waste management system that does not include a MRS facility. Emplacement of packaged waste for disposal in the geologic formation is the functions that can only be conducted at the repository and would as a minimum require surface facilities for receiving, handling, inspection, and temporary storage of waste containers as well as facilities necessary to correct any problems encountered and the necessary support facilities.

The development of a repository designed to perform for at least 10,000 years is a unique, first-of-a-kind undertaking. Nothing in recorded history has been consciously designed to last this long(1). This type of geologic disposal is itself a very complex system of many dimensions involving integration between: waste form, waste package design and materials, and the repository configuration, media and environment. Although some very sophisticated models of the geochemical, thermal, rock mechanical, hydrological, and seismic phenomena have been developed our knowledge is by no means complete. It will be difficult to convince the Nuclear Regulatory Commission (NRC) and the public that there is sufficient understanding of all the phenomena and possible interactions involved to assure that the system will perform unattended satisfactorily over this period. Some serious questions have already been raised about the suitability of the Yucca Mountain site (1). Perhaps more serious, is the growing recognition that primary dependence on the geologic environment to isolate the waste may be a mistake (2). This is likely to result in extended delays in the repository program and will require redirection of the program through legislation to place greater reliance on engineered structures and to demonstrate if something goes wrong it can be fixed. In this situation geological disposal could become a form of indefinite monitored retrievable storage, but would be quite different from the current MRS concept being pursued by DOE.

The essential functions that must be conducted at the reactors is storage of the spent fuel and loading it into cask for shipment off-site. The are several options available to utilities for providing at-reactor storage depending on the particular circumstances at the reactor and preference of the utility (20). The first choice of utilities is to expand at-reactor storage by increasing the capacity of existing storage pools by using improved storage rack designs and better utilization of available pool space. Pool storage can be further expanded through the use of rod consolidation or other innovative approaches such as double tiering of storage racks. By taking the fuel assemblies apart and packing the fuel rods closer together rod consolidation permits more fuel to be placed in the same storage space. However, the extent to which these options can be used at individual reactors depends on the loads that can be safely imposed on the pool structures. In most instances the pool structures are probably adequate to accommodate the increased loads and in others it may be possible to reinforce pool structures. Wet storage of spent fuel in reactor pools is a temporary form of non-passive monitored retrievable storage which NRC has found to be suitable for at least thirty years beyond the expiration of nuclear plants operating licenses. For most reactors in operation today this technology can provide most of the spent fuel storage needs until about the year 2040, if necessary.

After a utility has utilized available at-reactor pool storage to the extent practical several option are available for utilizing away-from reactor storage or for providing additional on-site storage. In some cases a utility may be able to ship fuel to another reactor site where storage space is available. To assure that no reactor would be forced to stop operation due to lack of spent fuel storage space the NWPA provides for Federal Interim Storage (FIS). However, to qualify for FIS a utility but obtain certification from NRC that they are unable to provide their own storage and must pay the full cost of providing such storage. To date, no utility has expressed any interest in taking advantage of FIS.

Technically a large number of options for expanding at-reactor storage have been studied ranging from building additional pool facilities to the use of various forms of dry storage(20). Due to uncertainty in the amount of storage that may be required and other considerations utilities have shown a definite preference for modular storage facilities that can be added essentially as they are needed. The use of metal storage cask similar to transport cask and the use of concrete storage modules in which a sealed canisters containing the fuel assemblies is placed is dominant concepts being considered. In both of these concepts fuel is loaded into the container in the reactor pool, the water is removed and the container is placed in passive monitored storage in a secure area within plant site. While no formal ruling has been made by NRC these forms of storage should, from a technical standpoint, be acceptable for storage of 50 years or more.

There are a number of ways these metal cask can be designed to accommodate various degrees of integration into the overall waste management system (9, 20). These include:

- o single purpose storage cask,

- dual purpose cask suitable for storage and transportation, and

- universal cask suitable for storage, transportation, and serving as the disposal container in the repository.

The canisters used in the concrete storage module concept can also be designed to be compatible with foregoing metal cask concepts and be used in a similar fashion using a metal cask as a transportation overpack. Either approach can accommodate fuel that has been consolidated at the reactor and can be utilized for interim storage at a MRS facility or repository. DOE's cooperation and leadership would be needed to establish interfaces, standards, and incentives necessary for effective integration of at-reactor storage options into the overall waste management system. Otherwise, each utility will be left to their own devices, without standardization, in providing at-reactor storage which could greatly restrict and/or forgo future options that DOE has in optimization of the overall system.

The transportation system must interface with the reactors and the with MRS if one is in the system and/or with the repository. The basic technology is available to safely transport spent fuel from reactors to a MRS or repository and from a MRS to the repository. There are, however, many options available as to how to configuration the transportation system to be compatible with the spent fuel management options that are available at the reactors, the MRS and repository (16, 20). The traditional approach to transportation of spent fuel from the reactors has been by common carrier single cask shipment by truck or rail depending on reactor transportation access and cask handling capability. This concept evolved in the early days of nuclear power when emphasis was on fast turn-around of reprocessed fuel for recycle into the reactors and to achieve high utilization of the fleet of transportation cask. However, with the use of large numbers of multipurpose cask in the system cask utilization in transportation become unimportant and opens many other transportation system options. The use of multiple cask shipment by dedicated train has been shown to have the potential for greatly reducing transportation impacts (16). Since the number of cask needed for storage exceeds the number needed for transportation cask utilization is not a dominant factor in transportation system economics. This also allows the use the largest cask practical for shipment using heavy-haul vehicles and barge shipment to move the large casks to a nearby railhead where rail access to the reactor site is not available. Dramatic reductions in potential transportation impacts can be achieved for from-reactor shipments using this approach (16). DOE has already adopted this approach for shipments from a MRS facility to the repository.

From the preceding it is apparent that a very large number waste management system configurations are possible that can potentially meet the overall system functional requirements. The problem from a system standpoint is to design a system that meet the functional requirements while arriving at the best compromise in conflicting objectives that will be accepted if not supported by those stakeholders that can potently block the implementation of the system.

Independent review of DOE's MRS proposal by the State of Tennessee and the U.S. General Accounting Office (GAO) led to concurrence that DOE had not adequately considered alternatives to the proposed MRS (3, 4, 20). Analysis by contractors for the State of Tennessee suggest that an improved NO-MRS alternative could be designed to have many of the advantages and functions as DOE's proposed system configuration with a MRS facility as an integral part of the system. The study for the State of Tennessee acknowledges that some reasonable people can conclude that the MRS is desirable because of the programmatic benefits perceived by DOE even though it cost more than a system with No-MRS. The study, also indicates that other reasonable people can conclude that a properly designed NO-MRS alternative is preferable. That choice will depend on the importance that is attached to various criteria that a used to compare alternatives.

2. WHAT IS THE SYSTEMS APPROACH? (5, 6)

In the systems approach components or sub-systems are viewed as part of a larger system and is explained in terns of their role in the optimization of the larger system. This way of thinking is based on the observation that, when each part of a system performs as well as possible, the system as a whole may not perform as well as possible. This follows from the fact that the sum of the functioning parts is seldom equal to the functioning of the whole. The design of a large complex system should be performed by a team possessing the necessary knowledge integrated into an effective project organization and assigned the responsibility of developing the type of system that will be responsive to the need. They must be cognizant of the interfaces between their respective specialty areas and economic factors, political factors, ecological factors, societal factors and the like which is the systems environment in which the system must operate. The design of the system must take into account public policy and institutional considerations as well as traditional technical considerations. Decisions require consideration of these factors in the early stage of system design and development, and the results of such decisions have a definite impact on acceptability of the proposed system design.

Systems engineering is the process employed in the evolution of systems from the point when a need is identified through production and/or construction and ultimate deployment of that system. It involves the following steps or phases:

Phase 1. Transformation of an operational need into a description of system performance parameters and a preferred system configuration through the use of an iteration process of functional analysis, synthesis, optimization, definition, design, test, and evaluation.

Phase 2. Integration of related technical parameters to assure compatibility of all physical, functional, and program interfaces in a manner that optimizes the total system definition and design.

Phase 3. Integration of performance, producibility, reliability, maintainability, manability, supportability, and other specialties into the total engineering effort.

Initially systems engineering is concerned with defining a mission statement that defines a set of objectives that grows out of a need or set of needs. It should precisely define the desired condition to be created rather than describing a system imagined to be adequate to fulfill the need. Fundamental to mission definition is the expression of the customers values by which the customer will evaluate the acceptability of a proposed solution. If properly defined, the mission statement does not usually change during design, development and construction of the system. The mission statement provides:

- a consistent, unifying objective for all conceptualization and design activities,
- the driving force and guiding light for all planning, and
- the rational for scope, cost, schedule, approach, design, research, development, testing, reviews, decision-making, quality assurance, and documentation.

From a systems approach standpoint the key to successfully designing, developing and implementing a system is satisfying the customer.

3. WHO IS THE CUSTOMER?

The notion of satisfying the customer is easy to accept since it is the basis for most successful business. However, who is the customer for the nuclear waste management system? The nuclear utilities that produce the spent fuel might consider themselves the customer since they are required to pay. DOE's contractors view DOE as the customer since they are hired by and paid by DOE who must be satisfied with their work product. While the utilities and DOE are in a limited sense customers, they are not the primary customers for the waste management system. The framers of the Nuclear Waste Policy Act (NWPA) of 1982 establishes the need for the waste management system and identifies the customer. In Section 111 of the NWPA , Findings and Purposes, Congress finds that:

(1) radioactive waste creates potential risk and requires safe and environmentally acceptable methods of disposal;

(2) a national problem has been created by the accumulation of

  (A) spent nuclear fuel from nuclear reactors; and

  (B) radioactive waste from

    (i) reprocessing of spent nuclear fuel,

    (ii) activities related to medical research, diagnosis, and treatment; and

    (iii) other sources;

(3) Federal efforts during the past 30 years to devise a permanent solution to the problems of civilian radioactive waste disposal have not been adequate;

(4) while the Federal Government has the responsibility to provide for the permanent disposal of high-level radioactive waste and such spent fuel as may be disposed of in order to protect the public health and safety and the environment, the cost of such disposal should be the responsibility of the generators and owners of such waste and spent fuel;

(5) the generators and owners of high-level radioactive waste and spent fuel have the primary responsibility to provide

for, and the responsibility to pay the cost of, the interim storage of such waste and spent fuel until such waste and spent fuel is accepted by the Secretary of Energy in accordance with the provisions of this Act;

(6) State and public participation in the planning and development of repositories is essential in order to promote public confidence in the safety of disposal of such waste and spent fuel; and

(7) high-level radioactive waste and spent nuclear fuel have become major subjects of public concern, and appropriate precautions must be taken to ensure that such waste and spent fuel do not adversely affect the public heath and safety and the environment for this or future generations.

Pursuant to these finding the Congress then sets forth the following purposes:

(1) to establish a schedule for the siting construction, and operation of repositories that will provide a resalable assurance that the public and environment will be adequately protected from the hazards posed by high-level radioactive waste and such spent nuclear fuel as may be disposed of in a repository;

(2) to establish the Federal responsibility, and a definite Federal policy, for the disposal of such waste and spent fuel;

(3) to define the relationship between the Federal Government

and the State governments with respect to the disposal of such waste and spent fuel; and

(4) to establish a Nuclear Waste Fund, composed of payments made by the generators and owners of such waste and spent fuel, that will ensure that the cost of carrying out activities relating to the disposal of such waste and spent fuel will be borne by the persons responsible for generating such waste and spent fuel.

From this the following roles are evident:

- o the public is the primary customer who must be satisfied,
- o the Federal Government (DOE) is the public servant charged with the responsibility of carrying out the program,
- o the State governments are delegated public representation responsibility, and
- o the utilities (generators and owners) is identified as the party that must pay the full cost of providing a solution to a problem they created.

From a systems engineering standpoint DOE has the responsibility to design and optimize a technically sound waste (high-level waste and spent fuel) management system responsive to publics values in consultation and cooperation of affected State governments. DOE is responsible for performing the work and is accountable to the Congress. DOE's contractors, labs and field offices look to DOE's

Office of Civilian Radioactive Waste Management (OCRWM) as their customer for the technical work. Within this context OCRWM would be responsible for providing overall system integration and guidance in defining the value criteria and their relative importance in performing trade-offs between major system components and within sub-systems.

The utilities (generators or owners) appear to have only two responsibilities under the NWPA. These are:

(1) provide for any interim storage that may be required until DOE has a geologic repository ready for operation and accepts the waste for disposal; and

(2) pay the full cost for disposing of their waste. There are, however, some implied utility responsibilities that arise from funding mechanism provided in the NWPA.

The NWPA requires utilities to enter into a contract with DOE which provides for the utilities to pay a mill per kilowatt hour fee on electricity produced by nuclear power subject to adjustment as required to pay the full program cost incurred by the government. If a utility declines to enter into the agreement they would loose their NRC license to operate the affected nuclear power plant. Under these conditions the fee is similar to a federal tax on nuclear power generation and would be a direct pass-through to the utilities electric customers. This arrangement removes the liability associated with spent fuel disposal from private utility stockholders and places it on the electric ratepayer.

Electric rates for private utilities are regulated by state public utility commissions (PUCs) who represent the public interest in establishing allowable electric rates. Ordinarily PUCs must allow utilities to pass trough the nuclear waste fund fees unless they can show that the utility acted impudently in incurring the cost. This implies that utilities might have some responsibility in providing oversight to DOE's performance under the NWPA. The PUCs have a responsibility to the public and ratepayers but do not have the organization or resources to effectively oversee DOE's performance and must look to the utilities. Investor owned utility management have a potential conflict of interest when undertaking to represent the interest of their stockholders and ratepayers. It should also be noted that the utility industry and other elements of the nuclear industry have a vested interest in encouraging a timely and acceptable solution to nuclear waste disposal since it is a prerequisite to the future viability of nuclear power in this country.

While the public is the primary customer for the high-level nuclear waste management system it is not easy to determine who represents the public. This responsibility falls to elected officials at the state and federal level who must periodically answer to their constituents and is augmented by input from various public interest groups which represent some special segment of the public. It is probably more appropriate to think in terms of a hierarchy of stakeholders rather than a single customer for high-level nuclear waste management system. TABLE I presents a hierarchy of the authors ranking of stakeholders in the order of the importance of their values relative the customers values in arriving at the preferred waste management system configuration and detailed optimization of the system.

TABLE III.1 - A HIERARCHY OF STAKEHOLDERS IN THE CIVILIAN RADIOACTIVE WASTE MANAGEMENT PROGRAM

The General Public

Affected State Governments

Congress

Electric Ratepayers

Public Interest Groups

Public Owned Utilities

Public Utility Commissions

Investor Owned Utilities

Nuclear Industry Suppliers

DOE's OCRWM

DOE's Field and Program Offices

DOE's Laboratories and Contractors

DOE Headquarters

In this hierarchy is seen that the importance of the stakeholders values decrease almost directly with the decrease in the stakeholders accountability to the public. It should be noted that the technical expertise is near the bottom. This should not be taken to mean that the technical aspects of arriving at the preferred system configuration are not important. High quality technical input is essential and any approach that is not technically sound is not a viable option. Technology should serve to provide the best possible system solution in terms of the customers values in order to arrive at a solution that has a high degree of acceptance and can be implemented.

4. WHAT IS IMPORTANT (VALUE CRITERIA)?

In order to design a system to meet a particular need the system designer should understand the customers values and weights by which the acceptability of the proposed system design be judged. With this information the system designer can formulate responsive alternative system concepts. Each alternative concept should then be systematical optimized in an iterative process to provide the best system design for that concept in terms of defined value criteria. In some instances concepts that are just a variation in the same approach will be eliminate since in the optimization process the will converge to the same system solution. Alternative system configuration concepts that have been properly optimized should then be evaluated by determining how well they meet each criteria and then be compared on well they meet all criteria taking into the account the weight appropriate to that criteria.

A knowledge of the customers values, or in this case a hierarchy of stakeholder values, and their related weights is essential to the design, optimization, and evaluation of alternative waste management system configurations. The NWPA provides some insight into some of the value criteria the Congress had in mind. These were:

- o precautions must be taken to ensure that such waste and spent fuel do not adversely affect the public health and safety and the environment for this or future generations,
- o by prescribing procedural details tied to a rigorous schedule it is implied that the Congress intended that a high priority be given to carrying out the program on a timely basis, and
- o cost was not mentioned as an important consideration.

Congress, however, did not undertake to define a detailed set of value criteria but did provide for state and public participation in order to promote public confidence in the safety of disposal of such waste and spent fuel.

The value criteria and related weights that DOE used and results of systems studies performed in arriving at DOE's preferred waste management system configuration including a MRS facility are not available. DOE has conducted a number of workshops largely in the transportation area to obtain input from interested parties and has undertaken to develop consultation and cooperation agreements with affected states. It, however, is not clear how these influenced the value criteria used by DOE.

An effort was made in a project in response to a DOE Program Research and Development Announcment (PRDA) to develop a stakeholder value structure appropriate for designing and evaluating spent fuel management system configuration alternatives (7). The value criteria shown in TABLE II was developed in a PRDA project peer review workshop in early 1984 by Dr. Ralph Keeney. Separate value structures for groups representing Public, Government, and Technical interest were developed then combined to produce this composite structure. The value structure for each group was developed getting the participants to identify "what is important". In the process, two concepts were utilized repeatedly. One concept is the separation of means and ends to the degree possible, and the other is specification of impacts that can be minimized or maximized as appropriate. When a concern or issue was identified, the question of why is that important" was pursued until the end effects were identified. This also avoids double accounting. This is not intended to indicate that means are unimportant, but rather that they are important for the effects on the ends. The results from the three panels were then integrated and modified into one overall hierarchy of value criteria, taking care not to loose important points brought out in the

TABLE III.2 - VALUE STRUCTURE FOR EVALUATING METAL CASK SYSTEMS FOR SPENT FUEL MANAGEMENT

1. Health and Safety	P
from Radiation Exposure	
Public	PGT
Worker	PGT
from Transportation Accidents	
Public	PGT
Worker	PGT
Future Generations	
Genetic	P
Cancer	P
2. Economic	G
State Governments	G
Federal Government	PGT
Utility Companies	PGT
3. Environmental	G
Visual	PG
Land Use	PG
4. Political	G
Public Confidence in the Technical System	PG
Public Confidence in Government	G
Local and State Attitudes	G T
5. Social	P T
Fears, Anxieties	P
Transport System(inconvenience)	T
6. Fairness	PG
Equity	G
Transportation Workers, Industry Workers, Public	G
Geographical	G
Beneficiaries of Nuclear Power	P
Intergenerational	P
Liability	P
7. Scheduling	T
Timely Availability of System	GT
Ability to Handle Appropriate Quantities	T
8. Flexibility	T
Technical	
with respect to Consolidation	T
with respect to Reprocessing	T
with respect to Plant Types	T
with respect to Retrievable	G
with respect to Repository Media	GT
Institutional	
with respect to Transport Regulation Changes	T
with respect to Regulation Changes	PGT
with respect to Political Changes	P

workshops. The letters P, G, and T indicated in the right margin indicates criteria emphasized by the Public, Government, and Technical panels respectively.

The scope of the waste management considered in developing this value criteria included all components of the system from generation of waste at the reactor through disposal in the repository but excludes performance of the geologic disposal media. Therefore, this value structure is appropriate for developing and evaluating overall waste management system alternatives with or without a MRS in the system. A detailed description of the development of this value criteria structure is included in Volume III - Appendix G of reference 7 together with an explanation of its intended use. This basic value structure is used in this study to compare important attributes of alternative waste management systems based on a MRS facility as an integral part of the system and a system based on full integration of dual purpose cask into the system.

5. DOE'S SYSTEMS PRACTICES?

Prior to the passage of the NWPA the DOE had primary responsibility for only the repository part of the waste management system. DOE was also supporting some research and development work on at-reactor storage options in cooperation with the Tennessee Valley Authority and doing transportation modeling work to estimate the impacts related to spent fuel transportation to the repository (9). Industry was responsible for providing any at-reactor storage that might be needed and for delivering the spent fuel or reprocessing waste to DOE at the repository. There was no overall systems approach to developing and implementing a waste management system. The repository program, at that time, was actually a contest between three competing projects for the first repository based on the use of salt, basalt, or tuff and was managed more as a "horse race" than a systems approach to program management. The DOE was a highly decentralized organization with primary responsibility for developing and managing programs delegated to DOE field offices. The creation of the Office of Civilian Radioactive Waste Management(OCRWM) in DOE by the NWPA created a new working environment in which DOE was responsible for the overall waste management system starting with the at-reactor storage interface with the utilities. Perhaps an even greater change for DOE was that essentially all aspects of the program would come under the regulatory jurisdiction of the Nuclear Regulatory Commission and other agencies and it was clear that the Congress intended to have meaningful public participation in the process with cooperation and consultation with the states. This was a new experience for DOE management which had been largely sheltered from the revolution in nuclear regulation and environmental accountability that had taken place since the mid 1960's. DOE was accustomed to deciding what they wanted to do, getting it authorized by the congress, and then proceeding with little or no outside participation or oversight.

DOE elected to fit the civilian radioactive waste management program into DOE's decentralized program structure with a relatively weak OCRWM management structure with little relevant experience or knowledge of the nuclear industry. There was also an extended delay in appointing a permanent OCRWM director. Under these conditions OCRWM looked to the DOE Field Offices and their contractors for input into shaping the program. They in turn shaped their part of the program to respond to their own needs, interest and capabilities rather than responding to overall program needs. The OCRWM did not have the organization or resources necessary to carry out a meaningful systems approach to designing and management of the waste management system.

TVA and others encouraged DOE to take a systems approach to developing and management of the waste management system. In response DOE established a small systems staff in OCRWM with essentially no control over the design of the waste management system. They were, however, interested in identifying the most efficient waste management system that is practical that fulfills the intent of the NWPA. An effort was initiated to work closely with utilities and industry to identify the best ideas from a total systems point of view. In 1984 DOE issued a competitive solicitation called a

Program Research and Development Announcement (PRDA) to develop technical and institutional alternatives for near-term and long-term handling, packaging and storing of spent fuel in ways that could facilitate and/or minimize handling and packaging for final disposal (10). Emphasis was placed on how an improvement in one part of the system will affect the total system in terms of cost, safety and licensing. Twenty-seven study proposals were received and contracts were awarded for five projects for which the following initial studies were completed:

- E.R. Jhonson to study the advantages of a multi-purpose centralized packaging facility (12),

- NUS to study the advantages of using a combination of square and half-square canisters designs for consolidated fuel rods (14),

- TransNuclear to study the use of extra large cask, triangular canisters, and a compact mobile rod consolidation process (11),

- Westinghouse to perform an integrated system study of metal cask systems including dual purpose cask for storage and transportation and a universal cask that is also suitable for use as a disposal package (7), and

- GA Technologies to study the design of a multi-element standard canister for use with various overpacks for storage and transportation (13).

DOE announced that a second round of PRDA projects was planned to follow up on concepts that showed promise.

All of these studies provide some useful input into identifying options that might be useful but are not a substitute for the type of integrated systems effort that should have been carried out within DOE to design the waste management system. The Westinghouse PRDA project did undertake to use systems engineering methodology in conjunction with multi-attribute utility analysis in an effort to incorporate stakeholder value criteria into the evaluation of alternative waste management system configurations.

In addition to the PRDA studies DOE was conducting other studies and indicated a desire to coordinate their work with other industry efforts such a systems studies being performed by TVA and the Electric Power Research Institute (16, 17). DOE indicated an intent to utilize results of these efforts along with existing design data to define the optimum waste management system in a Systems Design Description (SDD) document (10). This SDD document was to be used by the individual programs to redirect, if necessary, current design efforts. While DOE was not using a formal systems engineering process it did appear that they were undertaking to explore alternatives with the appropriate objective of optimization of the waste management system from the source of the fuel to the final disposition in a continuing relationship with industry.

Until Bernard Rusche became the first permanent OCRWM director MRS was viewed by DOE as a last resort to be implemented only if there are extended delays in the repository program. Mr. Rusche brought with him a personal commitment to began accepting spent fuel from utilities by 1998 and a design to make the MRS an integral part of the waste management system. The PRDA program fell into disfavor and DOE focused attention on justification of the MRS as a centrally located packaging facility that would also provide buffer storage of spent fuel. DOE did not permit the Westinghouse PRDA project team to complete the first phase of the project by reviewing the work with the peer review group used to develop the value criteria previously discussed. DOE's top management felt the project was undermining their position on the MRS and saw the workshops as" educating the enemy". DOE canceled plans for continuation of the PRDA program and turned their systems effort to the task of interfacing the proposed MRS with the reactors and potential repository designs linked together by the transportation system (15).

DOE abandoned development of promising concepts and avoided any contingency planning choosing to place all their eggs in the MRS basket. DOE did, however, in response to utility industry support commit to including development of a dual purpose cask in a transportation cask acquisition program that was hurriedly put in place to have the transportation fleet in place to support initial operation of the proposed MRS in 1996. The dual purpose casks were later eliminated from the program. No systems studies are available to support DOE's decision to proceed with implementing the traditional transportation system concept on which the acquisition program was based. This traditional concept utilizes single cask shipment in general commerce by rail or truck to move the fuel from reactor sites. Systems studies performed by TVA indicate that DOE was premature in rushing to implement this approach. The TVA studies strongly suggest that a transportation system base on the use of a family of standardized multi-purpose cask in conjunction with multiple cask shipment by special dedicated trains would be more effective from an overall system point of view as well as being more acceptable to the stakeholders (16, 17).

The Congress, as previously discussed, intended that there be effective consultation and cooperation between DOE and the states as well as active public participation. Under Mr.

Rusches' leadership the relations between DOE and the states continued to decline. The states believed that they should be involved in the whole decision making process from beginning to end as a full partnership. DOE saw consultation and cooperation as allowing the states to react after DOE has defined its position. DOE felt that by permitting the states to participate and influence DOE decisions DOE could undermine DOE's responsibility to manage the program. A study for the nuclear utility industry by a communications consultant concludes that DOE's problems with the states "have every bit as much to do with attitudes and skills as it does with mechanisms"(18). Typical complaints the consultant received from the states about OCRWM's attitude were:

- "They still have the old AEC mind-set the public doesn't need to know, and is in their best interest not to know."
- "There's this wall. You can tell they just don't understand the social ramifications and public perceptions involved."
- "When they hold briefings you can tell it is just an exercise. The underlying attitude comes through."
- "The overwhelming impression is of complete dogmatism: this is the way it is."
- "The problem is that DOE doesn't even know what it is they are doing wrong."
- "DOE was arrogant. This is a hangover from the AEC days, but the states aren't used to having to deal with

it. Industry is much less arrogant than DOE."

- "They have a bureaucratic outlook which gets communicated to the public. Basically what they communicate to the public is "I'm DOE and I'm the expert. You're the local yokel from the boonies. You can't expect me to take the time to educate you. Here's a stack of reports. If you have questions I'll answer them."

Under these circumstances it is not surprising that the consultation and cooperation process broke down and turned into an adversary process with the states resorting to litigation to be heard. An open and honest systems approach in which the states and public participation is encouraged throughout the process can be used to move toward building a consensus around solutions to problems that have a increased probability of being successfully implemented. In such a process all participants have some degree of ownership in the preferred solution that evolves and know that their values and concerns were appropriately considered and weighed in the process. There are definite risk all parties in such a process. It would be necessary for DOE to give up some control over the outcome and some stakeholders may forgo their most potent arguments if they find the solution unacceptable.

As was previously noted, when framing the NWPA, the Congress was very aware of the need for public participation and development of public confidence in the safety of the disposal system. This is a matter of establishing and maintaining trust and credibility which can be accomplished through the use of an open and objective systems approach as previously described. The OCRWM inherited a long history of well deserved public distrust of the governments nuclear waste management activities from DOE and it's predecessors. This was a difficult obstacle to overcome even under the best of circumstances since their was a predisposition to distrust OCRWM. The prospects for developing the necessary public trust was made virtually impossible since DOE management felt they could not trust the states, the public, or any one not on their team that might not agree with them. Their approach was you are either with us or against us and they declined to cooperate with those that did not support their position. Through a series of the following actions DOE brought their credibility into question leaving the nuclear waste management program in shambles:

- o DOE decided that Oak Ridge, Tennessee was the preferred location for the proposed MRS then proceeded to have their contractors contrive to define a broad region centered around Oak Ridge as the area in which a MRS should be located to minimize transportation impacts (19).
- o DOE and it contractors did a poor job in justifying the need for the proposed MRS (21). The State of Tennessee had little difficulty in showing that many

of the benefits DOE claimed were greatly exaggerated or highly subjective and that a properly designed NO-MRS could provide most of the benefits claimed for the MRS(3).

- o States were excluded from participation in selecting three sites to be characterization for the first repository and did not agree with the methodology that DOE had used. The National Academy of Sciences supported the states assessment of DOE's methodology but did agree that an alternative methodology proposed by DOE using multi-attribute utility analysis would be satisfactory if properly applied. DOE utilized the values of DOE personnel and contractors in performing the evaluation without allowing other stakeholder input. The results of the site ranking using this methodology was different than DOE's original choices. However, DOE top management elected to apply criteria not considered in the multi-attribute analysis to justify selecting their original three choices of sites for characterization.
- o After denying that any such action was under consideration DOE suddenly suspended the site selection process for the second repository. This action was taken under circumstances that created the perception that the action was taken in response to partisan political pressures to help some candidates

in congressional elections.

Whether these were good decisions or not is not as important as the perception created that DOE was not honest or competent. In either case it is not the kind of performance that would inspire public confidence and raises the credibility issue. That is, if DOE can not be believed about these things then what reason is there to believe them about safety or other aspects of the system. It is not clear what value criteria DOE used in reaching its decisions. Much of the evidence seems to suggest that DOE engages in reverse systems engineering. That is, the criteria is optimized to produce a predetermined decision. If DOE had taken a systems approach to addressing these issues and worked with the stakeholders to define the value criteria to be used in making decision as it is likely that the loss of credibility could be avoided. DOE does not seem to recognize that it is conducting the publics business which should be done in an open and honest way to earn the necessary public trust essential to successful implementation of the waste management system.

Many individuals and organizations including the Atomic Industrial Forum and American Nuclear Society have consistently encouraged and prodded DOE to take an integrated systems engineering approach to designing and management of the nuclear waste management system. This was done through personal contacts and industry committee meetings with DOE's top management and through sponsoring seminars and workshops. DOE has not been fully appreciative of these efforts and has tended to look upon then as unwarranted intrusion into DOE's business. The most notable of these efforts was an ANS Topical Meeting/Workshop on "The Integrated Spent Fuel and HLW Management System" conducted in September 1987 (23). The sponsors made an effort to keep the meeting from becoming a DOE bashing and contended that the meeting was neither to criticize nor to advise OCRWM. There was good attendance and excellent participation by a wide range of largely technical interest in the waste management program. The dominant recurring themes raised by workshop groups was the lack of communications and need for a systems engineering process. In the assembly meeting DOE management and their support contractor (Weston) contended that they have been doing extensive systems studies to support their decisions but did not attempt to explain why the studies were not available. The proceedings of the meeting provides some very useful input into the justification for and scope of the needed system approach. While not published the discussions in the working groups were critical of several DOE practices, such as:

- Not providing for adequate peer review,
- Requiring the contractor to use assumptions and/or defining the scope of work in a manner that the contractor is not comfortable with the results of

their work and which is sometimes used out of context by DOE to support a position, and

- o DOE's practice of delaying or withholding results of studies that may not be supportive of DOE's position.

Two of the white papers presented in the plenary session were by prominent utility industry technical managers. Neither of these took the opportunity to promote the system benefits of a MRS facility. One specifically said " There are few if any benefits to be realized to compensate for the disadvantages of the DOE proposed Integrated MRS".

DOE's so called systems studies that are available appear to be efforts to defend a DOE position. Typical of this practice is an analysis of some alternative system configurations that DOE performed (22) in response to system design criticisms by the State of Tennessee (3, 20) and the U.S. General Accounting Office (4). The study compares a series of five variations of DOE's reference NO-MRS systems configuration with increasing reliance on at-reactor rod consolidation and packaging in conjunction with the use of larger shipping cask. This was a very limited comparison of system configuration variations and in no sense represented a systems engineering effort to design and optimize a NO-MRS system configuration along the lines suggested by the State of Tennessee by integration of a family of dual purpose cask into the overall system. Not surprising, DOE concludes "Nothing in this analysis indicates the need for any substantiate changes in the conclusions reached in the DOE's proposal about the system benefits and cost of an integrated MRS facility". In this work or in any other work, DOE does not describe or provide any reference to the type of NO-MRS system configuration that has been suggested by the State of Tennessee. DOE also includes in the report a section on the views of utilities related to the MRS in which they:

- o undertake to refute the results of a GAO survey that questioned the support of utilities for the MRS, and
- o reports on a limited survey of eight utilities about their attitude towards performing consolidation and packaging operations at multiple reactor sites not designed for such activities.

The questions DOE asked the eight utilities were carefully crafted to elicit concerns about performing such operation at-reactors in a way that could interfere with plant operation. Predictably the utilities in general would prefer to do the least amount of work possible at the reactor site and have DOE take their fuel as soon as possible. It may, however, be desirable, in the interest of the public and their rate payers, for utilities to conduct some operations at-reactors that are practical and effective in the overall optimization of the system. The integrated dual purpose cask system configuration has the flexibility to accommodate a wide range of at-reactor activates to accommodate the particular circumstances at each reactor and the operators preferences.

OCRWM decided to turn the systems engineering function over to a contractor who would also perform many of the program management functions. In October 1987 a request for proposals (RFP) was issued for a Management and Operating Contractor for Systems Engineering, Development and Management (SEDM) of the Nuclear Waste Management System (24). The solicitation for the SEDM Contractor was revised in February 1988 to reflect program changes due to the 1987 NWPA Amendments. The responses were due in April 1988 and it is anticipated that a contract will be awarded by 1989 and be in full implementation by 1991.

The SEDM contractor, or what has become known as the "super gorilla" contractor, will be responsible for the design and analysis of the nuclear waste system to ensure that the system is optimized and that the interfaces between the system elements are clearly specified and controlled, including transportation considerations. The contractors work is to include integrating the work of various program participants, such as National Laboratories, other federal agencies, and DOE Prime Contractors conducting work in support of the program. This appears to be the first real step by DOE towards a meaningful systems approach to designing the waste management system. The ten year contract at an average estimated cost 100 million dollars per year should provide adequate resources for the job.

The SEDM contractor, however, does not have the liberty to consider alternative system configuration concepts since the scope of work starts with Phase II of the system engineering function previously described requiring the contractor to optimize the system configuration specified by OCRWM. The RFP does not specifically address the value criteria to be used by the contractor for performing optimization trade-offs beyond working under the technical direction of OCRWM. The RFP does provide for the contractor to assist DOE as require in its interaction with affected States and other affected parties as recognized in the NWPA to ensure that the consultation and cooperation required by NWPA is successfully implemented. From the SEDM Contractors perspective the sole customer for the waste management system appears to be OCRWM. The SEDM contractor might improve OCRWM's ability to manage the overall program but does not correct the problems related to control by DOE's Field Offices. There is, however, the possibility that the SEDM contractor will just add another layer of bureaucracy to the program making program management more remote and less responsive to the waste management system customers.

The 1987 NWPA Amendments that authorized the MRS and established the MRS Review Commission to compare the proposed

MRS to the alternative of at-reactor storage and to report on the need for a MRS facility also directed Doe to:

> "conduct a study and evaluation of the use of dry cask storage technology at the sites of civilian nuclear power reactors for the temporary storage of spent fuel until such time as a <u>permanent geologic repository has been constructed and licensed by NRC and is capable of receiving spent nuclear fuel</u>".

It appears that the Congress intended for DOE to study and evaluate at-reactor dry cask storage as an alternative to the proposed MRS, but did not explicitly spell this out in the legislation. DOE published the draft report "Initial Version: Dry Cask Storage Study" in August 1988 for comment as required by the legislation. In the report DOE elected to narrowly interpret Congress's direction and placed primary emphasis the status of dry cask technology rather than taking a systems approach to examining the integration of dry cask technology effectively into the overall waste management system. DOE did a good job of reporting on the status of the technology and came to the conclusion that had precipitated Congress's interest in the study in the first place. That is:

> "The DOE concludes that these existing technologies are technically feasible, safe, environmentally acceptable options for storing spent fuel at the sites of civilian nuclear reactors until such time as a <u>Federal facility is available to accept the spent fuel</u>".

Note that DOE took the liberty of changing the scope of at-reactor storage in the study from when a "permanent geologic repository has been constructed and licensed by NRC and is capable of receiving spent nuclear fuel" to when "a Federal facility is available to accept spent fuel".

Presumably the Federal facility DOE has in mind is the MRS. The lack of a systems approach was noted by NRC in their comments on the report and NRC writes that DOE should apply systems analysis to the entire spent fuel management system to "achieve cask design compatibility to the greatest extent possible". NRC charges that:

> "inadequate attention is being given to ensure the compatibility of the various steps in storage, transport, and disposal of spent fuel and thereby to enhance the safety and efficiency of fuel handling."

It was clear that NRC recognized the potential benefits that can be gained from effective integration of multipurpose cask technology into the overall waste management system. NRC presented the following argument:

> "With a proliferation of storage options, it appears likely that fuel to be removed from reactor sites in some instances may have to be returned to reactor pools to unload and then load into transportation cask for shipment of site. In addition subsequent operations at the repository, or a monitored retrievable storage(MRS) site, may be needed to repackage the fuel for ultimate disposal. The Commission believes that radiation exposures and other handling risk should be minimized in the entire process, from removing the fuel from the reactor pool the first time, to its ultimate disposal. System analysis and action at this early stage could result in minimizing these handling risks, and we suggest that DOE proceed on this course of analysis and action to achieve cask design compatibility to the greatest extent possible."

To assist the MRS Review Commission in considering the need for a MRS DOE has initiated a series of systems studies that examines several variables in design of the high level waste management system. Nine cases will be examined which include the following variables:

- o system configurations with and without a MRS in the system and whether western reactor fuel should be shipped to an eastern MRS,
- o system configurations in which rod consolidation is performed at the repository or at a MRS prior to disposal or no rod consolidation, and
- o system configurations that perform packaging for disposal at the repository or at a MRS.

DOE expects results of these studies to provide a much more detailed understanding of the relative advantages and disadvantages of including the MRS in the waste management system as these advantages and disadvantages are affected by the NWPA and will contribute to development of positions on MRS by DOE management.

These studies will provide some very useful information but are not systems engineering studies of the type needed to determine the best configuration of the overall waste management system. The value criteria by which the variations in the system configuration will be designed, optimized and evaluated is not clearly defined and the studies do not include integrated at-reactor storage and transportation options such as those that have been proposed by the State of Tennessee. DOE analysis examines some severely constrained system configurations rather than using the systems approach to examine alternative waste management system configurations. For those not familiar with utilizing the systems approach for designing of a system this might think this is an exercise in semantics, there is, however a great deal of difference.

In conclusion it is fair to say that DOE efforts in applying the systems approach to designing and optimizing the waste management system to gain acceptance by the stakeholders is poor at best. In fact it appears that DOE has deliberately avoided taking a systems approach and has actively discouraged its use by others. Moreover, DOE has consistently refused to include in their analysis a comparison of a their proposed system configuration with an Integral MRS to a NO-MRS system configuration based on the full integration of multipurpose cask into the system such as the integrated dual purpose cask concept that has been proposed by the State of Tennessee. There has recently been a move towards putting in place an organization and the expertise that is capable of implementing an integrated systems approach through the SEDM Contractor. The success of this effort will, however, depend primarily on the attitude of DOE management.

6. REFERENCES

1. Kenneth C. Rodgers, Commissioner U.S. NRC, "Systems Engineering in NRC's High Level Waste Program", Nuclear Plant Journal, July-August 1988.

2. Frank L. Parker, Chairman NAS Board on Radioactive Waste Management, "Interview", The Radioactive Exchange, August 1988.

3. University of Tennessee, "Evaluation of the Need, Feasibility, and Siting of the MRS in Tennessee", Waste Management Research and Education Institute, December 1985.
4. U.S. General Accounting Office, "Nuclear Waste--DOE Should Provide More Information on Monitored Retrievable Storage", GAO/RECD-87-92, June 1987.

5. B. S. Blanchard and W. J. Fabrucky, "Systems Engineering and Analysis", Printice-Hall, 1981.

6. ANS, "Systems Engineering: Nuclear Applications Workshop", Waste Management '87, March 1987.

7. Westinghouse and TVA, "Phase 1 Study of Metallic Cask Systems for Spent Fuel Management From Reactor to Repository", WTSD-TME-085, February 1986.

8. Arnie Wight, "Need for a Change: An AMFM Panel Perspective", Waste Management '85, March 1985.

9. Raymond E. Hoskins, TVA, "Integrated Cask Storage Systems for Storage, Transportation and Disposal of Spent Nuclear Fuel", Waste Management '84, March 1984.

10. Carl W. Conner, DOE, "Spent Fuel Management Strategies in the United States", Irradiated Fuel Storage: Operating Experience and Development Programs International Workshop, Toronto, Canada, October 1986.

11. Transnuclear, "A Study of Extra Large Storage Cask", DOE CONTRACT DE-AC01-84RW00038, December 1986.

12. E. R. Johnson Associates, "Assessment of the Use of a Multi-Purpose and Centralized Facility for the Disassembly and Packaging of Spent Nuclear Fuel to Support Various Segments of the Waste Management System", JAI-254, December 1985.

13. GA Technologies, "Commercial Radioactive Waste Management System Feasibility With the Universal Canister Concept", GA-A18320, December 1985.

14. NUS Corp., "An Assessment of the Use of Half-Square Cans

on the Management of Spent Fuel", NUS-4724, January 1986.

15. DOE, "Report of the Task Force on the MRS/Repository Interface", DOE/RW-0044, February 1986.

16. Raymond E. Hoskins, TVA, "TVA Systems Study: A Parametric Study of the Potential for Spent Fuel Transportation System Optimization", INMM Conf., January 1986.

17. Raymond E. Hoskins, TVA, "A TVA view of Spent Fuel System Integration and Optimization", 3rd International SFST Symposium/Workshop, April 1986.

18. James L. Creighton, "The U.S. Department of Energy's Implementation of the Consultation Provisions of the Nuclear Waste Policy Act", UNWMG, August 1985.

19. Raymond E. Hoskins, U of TN, "Identification of Geographic Areas for Siting a Monitored Retrievable Storage Facility to Minimize Transportation Impacts", Waste Management Research and Education Institute, January 1987.

20. Raymond E. Hoskins, U of TN, "Status of Spent Fuel Management Technology Related to DOE's Monitored Retrievable Storage Proposal", Waste Management Research and Education Institute, April 1987.

21. DOE, "The Need for and Feasibility of Monitored Retrievable Storage--A Preliminary Analysis", DOE/RW-0022, April 1985.

22. DOE, "Additional Information on Monitored Retrievable Storage", DOE/RW-0166, November 1987.

23. ANS, "Proceedings of Workshops: The Integrated Spent Fuel and HLW Management System", September 1987.

24. DOE, "REQUEST FOR PROPOSAL FOR A MANAGEMENT AND OPERATING CONTRACTOR FOR SYSTEMS ENGINEERING, DEVELOPMENT AND MANAGEMENT OF THE NUCLEAR WASTE MANAGEMENT SYSTEM FOR THE OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT", DE-RP01-88RW00123, FEBRUARY 1988.

25 DOE, "Initial Version: Dry Cask Storage Study", DOE/RW-0196, August 1988.

26 Radioactive Exchange, "NRC: DOE Should Push for Compatibility of Spent Fuel Cask Designs", November 21, 1988.

27 Radioactive Exchange, "DOE Staff Outline HLW Management System Studies to MRS Panel", Sept 31, 1988.

IV - ALTERNATIVE SYSTEM CONFIGURATIONS

In the initial phase of applying the systems approach to engineering the design of the overall waste management system it is essential to clearly define the mission of the system and its functional requirements and identify the customers values or criteria by which the effectiveness and desirability of alternative system configurations can be judged. In the preceding chapter it was shown that there is not a single customer for the waste management system but a hierarchy of stakeholders whose acceptance if not support is necessary to have a chance of being able to successful implement the system configuration that is judged to be "best" in terns of the stakeholders value criteria. It was also shown that the stakeholders value criteria are characterized in terms of the following attributes which can be used as the basis for design, optimization and evaluation of alternative system configurations:

1. Health and Safety,
2. Economic,
3. Environmental,
4. Political,
5. Social,
6. Fairness,
7, Scheduling, and
8. Flexibility

The system designer should have good working knowledge of each component of the system and how it interacts with other components of the system so the components can be effectively integrated to produce the "best" or optimum configuration of the system appropriately taking into account the weight or importance that the customer places on the value criteria or system attributes.

Utilities or generators of the waste are responsible for spent fuel management until DOE accepts the fuel for disposal and DOE is responsible for transportation, packaging, and disposal. It is desirable to optimize the overall system from creation of the waste in the reactors through ultimate disposal in the geologic repository from the standpoint of minimizing economic cost and keeping radiological dose commitments to the public and workers as-low-as-reasonably-achievable (ALARA). Utility payments into the Nuclear Waste Fund and utility cost incurred for storage are passed through to ratepayers with little or no risk or incentive to motivate utility management to utilize optimum system solutions. Therefore, the overall system integration and optimization responsibility falls on DOE which should provide the leadership, support and incentives for utilities' at-reactor spent fuel storage activities that improve overall system performance. If individual utilities are allowed to utilize storage alternatives that best meet their individual circumstances without any standardization or consistency, it could greatly complicate the spent fuel management system and increase overall system cost and forgo other benefits that can be realized through an integrated system approach to designing the waste management system.

There are a wide range of technological options available in each component of the overall system that can be put together in different combinations to produce a very large number of technically feasible system configuration alternatives. The process by which the alternatives are is narrowed down to a few for more detailed design, refinement, and evaluation is evolutionary and generally requires several iterations. Only three of the eight attributes can be quantified numerically to permit ready use of mathematical optimization techniques. Therefor, the process by necessity must be largely subjective. In this process optimization sometimes requires compromises in some components or sub-systems in order to provide greater overall system benefits. The alternative system configurations to be evaluated should be developed using the same value criteria and related weights. DOE has, to some degree, considered all of these criteria in their design but emphasis was placed on different attributes than those used in the design of the integrate dual purpose cask system configuration suggested by the State of Tennessee.

From a systems engineering standpoint DOE gave little consideration to integration of at-reactor storage and from-reactor transportation components of the system into the optimization of their Integral MRS system configuration. DOE placed great weight on schedule aspects of the program and emphasized flexibility in accommodating repository loading (2). Evolution of the INTEGRATED NO-MRS has it's origins in providing flexibility for at-reactor spent fuel management to minimizing dependance on DOE (5). System integration emphasis was placed on optimizing fuel handling and transportation operations to keep public and worker radiological dose commitments as low as reasonably achievable (ALARA) consistent with minimizing overall system cost.

1. SYSTEM CONFIGURATION DESCRIPTIONS

The following sections of this chapter provides system configuration descriptions of the No-MRS and I-MRS alternatives as described in DOE's proposal to Congress (3) and other program documents (2, 4) together with the descriptions of an integrated no monitored retrievable storage (I-No-MRS) alternative based on effective integration of dual purpose cask for storage and transportation into the overall system as suggested by the State of Tennessee (1, 7). System configuration flow charts are used to illustrate the principal sub-systems and interfaces for the alternative fuel management systems that will be discussed. The systems environment, important assumptions and system design considerations are also discussed. To assist those readers that may not be familiar with spent fuel management technology, important concepts are explained as they are introduced.

A. DOE's No-MRS Concept

A flow chart of DOE's No-MRS system configuration is shown in Figure III-1. This system consists of partitioned views of at-reactor storage, spent fuel transportation, and packaging of spent fuel for disposal at the repository. It is assumed that spent fuel is to be consolidated before packaging for disposal and the non-fuel scrap is to be compacted and packaged for disposal in the repository

Consolidation entails removing the spent fuel rods from their structural assembly and packaging the rods closer together. This permits more fuel to be placed in the same space and allows arranging fuel in more efficient configurations for packaging than the fuel assemblies used in reactors. Rod consolidation permits more fuel to be stored in the same physical space, increases the capacity of transport casks and storage containers or disposal packages.

The following description of DOE's No-MRS option was extracted primarily from DOE's proposal to Congress (2), the OCRWM Mission Plan (3), and other program documents.

At-Reactor Storage

It was assumed that DOE will begin accepting spent fuel for disposal in 1998 and utilities would provide any interim storage needed at the reactor or ship fuel to another reactor site where storage space is available. DOE assumes utilities will install high density pool storage racks to the extent practical, augmented by rod consolidation or dry cask storage as necessary.

When discharged from the reactor core, the highly radioactive

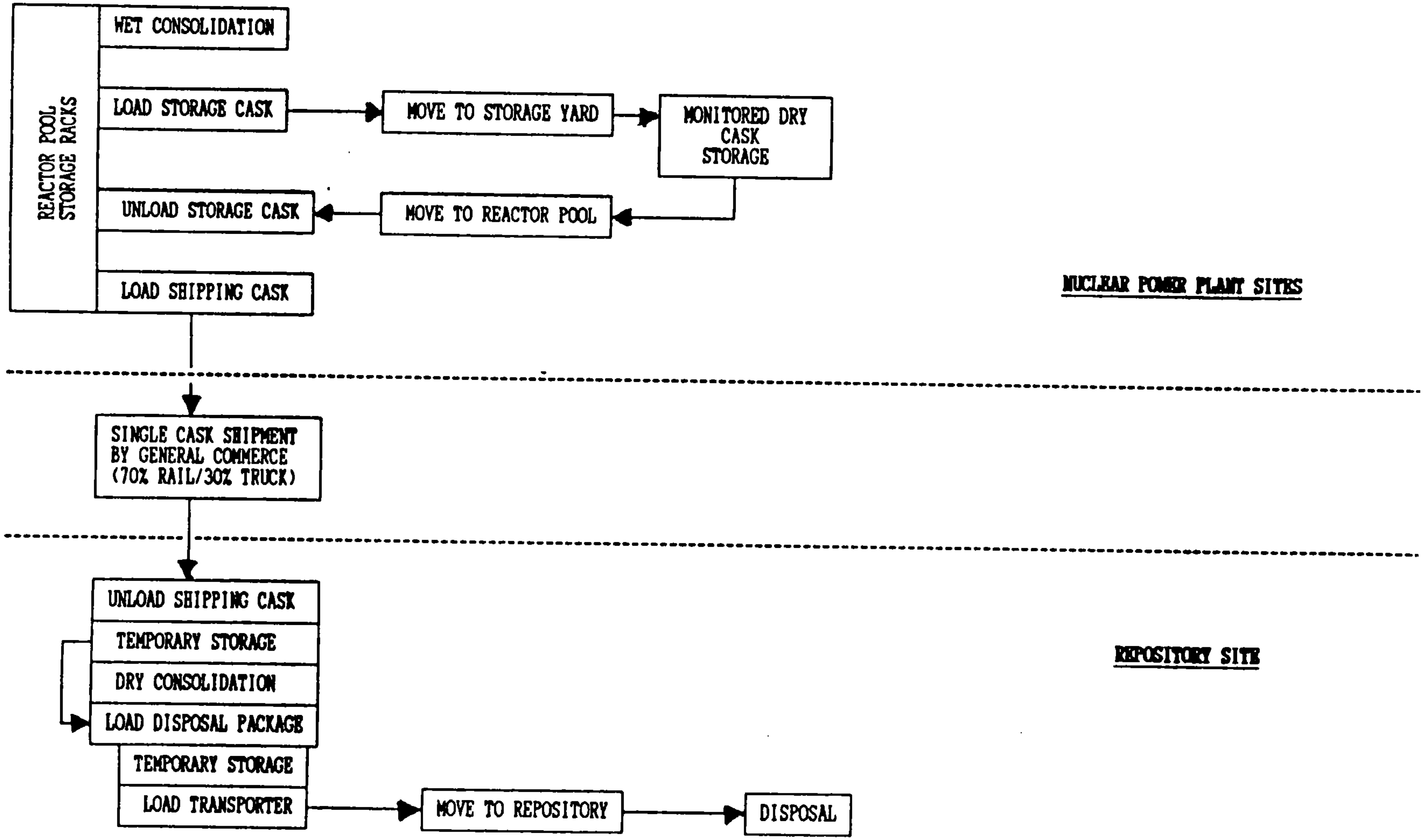


FIGURE IV.1 - DOE's NO-MRS SYSTEM CONFIGURATION FLOW CHART spent fuel is placed in storage racks in water pools where the radioactivity and related heat generation decay with time. Originally most reactor pools were designed to provide spent fuel storage for about six months until the fuel could be shipped to a reprocessing plant. Space was also provided in these storage pools to permit discharge of the full reactor core for inspecting and maintaining the reactor. Space was also provided for fuel handling, inspection and transportation cask loading. Most of the storage pools were conservatively designed, providing generous space for these operations. When there were delays and eventual abandonment of reprocessing in the United States, utilities expanded fuel storage in the existing pools by better utilizing the available space. Storage of aged spent fuel underwater for long periods of time is simple and reliable since the zircalloy clad oxide fuel used in the light water reactor is very resistant to degradation in this environment. NRC has formally ruled that such storage can be done safely for at least 30 years beyond the useful service life of the reactor.

Improved storage rack designs have evolved that permit closer spacing of fuel in the racks while providing for heat removal and criticality control. Many nuclear plants have gone through several rerackings as the need arose and improved rack designs become available. Nearly all reactors have been or will be re-racked at least once. In some cases the extent to which in-pool storage capacity can be expanded is limited by the strength of pool structures or other design limitations. There are several technical options for dealing with these problems, and the preferred approach in different situations will be dependent on individual plant circumstances.

In-pool storage can be further expanded by fuel rod consolidation if the utility obtains a plant license amendment by demonstrating to NRC's satisfaction that the pool structures, storage racks and auxiliary systems can safely accommodate the expanded storage. Rod consolidation is performed underwater in the storage pool where the water serves as a very effective biological shield and permits great flexibility in carrying out operations. There are several designs of underwater rod consolidation equipment that have been demonstrated to varying degrees, ranging from very simple equipment for extracting single rods to complex equipment for pulling all rods from a fuel assembly at the same time and arranging them in a compact configuration. There is little question about the technical feasibility of underwater rod consolidation due to its similarity to and extensive experience in reconstructing fuel assemblies to replace defective rods. However, more experience is needed to develop reliable equipment to efficiently consolidate fuel at rates suitable for large scale use.

The rod consolidation process generally consists of removing a fuel assembly from the storage rack and moving it to a consolidation work station where the rods are removed and packed in another storage canister that will fit in the fuel storage racks. When packed together, about twice as many fuel rods can be placed in a storage canister with the same cross section as the original fuel assembly. The fuel canister with the consolidated fuel is returned to the storage rack. During the consolidation operations water flow is controlled around the fuel and is filtered to collect any scale (crud) that may be dislodged from the fuel preventing its dispersion in the pool. The scale is collected in the reactor waste system, packaged, and disposed of as part of the normal low-level waste sent to a regional disposal site. The metallic non-fuel scrap from the fuel assembly is compacted to reduce its volume and placed in canisters similar to the fuel canisters which are also placed in the pool storage racks. Storage of the non-fuel bearing scrap in the storage racks reduces the efficiency of rod consolidation requiring more than two fuel assemblies to be consolidated to produce an additional storage space in the storage racks. The compacted scrap would be accepted by DOE for disposal in the repository or could, if properly segregated, be disposed of as low-level waste in a regional low-level waste disposal facility. At the present time there has been little progress between DOE and utilities in agreeing on standards for packaging of consolidated fuel or scrap. Moreover, consolidated fuel is considered to be non-standard fuel under the current DOE/utility contracts for which acceptance criteria or priority has not been established.

While monitored dry storage is only now being licensed by NRC for at-reactor use in the United States, it is a maturing technology that has been well demonstrated abroad and at DOE facilities. Passive modular dry storage in metal casks or concrete storage modules is the methods utilities prefer for at-reactor use. These modular forms of storage can be added as needed and are comparable with reactor site facilities and use. Aged fuel is stored in an inert gas in a sealed container and heat is dissipated to the environment through the container wall without the need for any mechanical assistance. Storage is monitored, and any corrective action that might be needed can be taken.

NRC licensing (under 20 CFR 72) for this type of storage is initially for a 20 year period with provision for renewal. With proper monitoring and facility maintenance, this type of storage can be extended for as long as may be necessary since there is no evidence that suggests that there is any significant degradation of the fuel or the fuel container takes place in this type of storage. Upon completion of dry storage, the cask or container will be moved back to the reactor pool, the fuel unloaded and placed in pool storage racks. The storage cask or container would be removed from the pool for decontamination and disposal. The fuel would then be loaded into a transport cask provided by DOE, drained, dried, decontaminated, prepared for shipment and turned over to DOE for shipment. When there is no further need for the storage cask, the materials would be salvaged, if practical, or disposed of as low-level waste at a regional low-level waste disposal facility.

At-reactor concrete storage modules are similar to dry cask storage except fuel to be stored is placed in a large sealed metal canister which is placed in a storage module constructed of reinforced concrete. A transportation or transfer cask is used to move the fuel canister from the reactor pool to the storage module and from the storage module back to the pool. It may be possible to avoid removing the fuel from the canister, permitting it to be shipped directly to the repository if DOE agrees to accept the fuel in this form and it can be accommodated by DOE's transport casks.

Transportation

A traditional transportation system is assumed by DOE for shipment of spent fuel from reactors to the geologic repository. DOE would accept title of the oldest fuel first at the reactor sites when ready for shipment. Fuel is assumed to have been in storage at the reactor for at least 5 years to be accepted. DOE contractors would be responsible for fuel shipment in NRC certified casks in accordance with NRC and DOT regulations.

The type of transportation system is typical of the approach that has been pursued over the past 20 years and has been updated to reflect higher cask capacities possible with aged fuel. It is assumed that fuel is shipped by rail from those plants that have rail access, and the rest is shipped by truck. This corresponds to about 70 percent shipment by rail and 30 percent by truck. It is assumed that single cask shipments are made by general commerce in nominal 100 ton rail casks or 25 ton truck casks.

Repository

Surface facilities at the repository receive and package spent fuel for disposal in boreholes in the underground geologic repository. It was assumed in DOE's Mission Plan that the repository would begin initial operation in 1998 and reach full capacity of 3,000 MTU per year in 2003. An amendment to the Mission Plan changed the initial date of operation to 2003. Defense high level waste and a limited amount of civilian high level reprocessing waste will also be received at the repository packaged for disposal, but, are not discussed in the following description.

Spent fuel would be received at the repository by rail and truck. Fuel would be unloaded from transportation cask into a dry hotcell environment and placed in temporary dry vault storage. Intact fuel assemblies would be removed from storage and consolidated using remotely operated equipment in a hot-cell behind thick concrete shielding walls. There is essentially no experience with dry consolidation of spent fuel except for some experimental work done at the AGNS Barnwell facility for DOE in the early 1980's. There are some similarities in the fuel disassembly operations at reprocessing plants. There is little question about the feasibility of dry consolidation, but only concern about achieving the necessary reliability and being able to maintain the equipment without excessive occupational exposure to radiation.

DOE has initiated a development program at the Idaho National Engineering Laboratory to demonstrate dry rod consolidation technology by 1989. Consolidated fuel would be sealed in disposal containers and placed in a dry storage vault, from which it would be loaded into a shielded transporter and moved to the repository for emplacement. Disposal container design has not been finalized and is dependent on the geologic media selected for the repository. The 1987 NWPA amendments designated a single site, Yucca Mtn., for characterization. Since there is a possibility that this site might not be acceptable the repository package design can not be finalized with a high degree of certainty. Non-fuel bearing scrap from the consolidation operations would be compacted and packaged for disposal in the repository.

B. DOE'S INTEGRAL MRS CONCEPT

The system configuration flow chart including DOE's proposed I-MRS concept as an integral part of the system is shown in Figure III-2. This concept evolved by inserting a central fuel packaging facility between the reactors and the repository to prepare a repository ready disposal package, which would eliminate licensing and implementation of related functions from the critical path of getting the repository into operation. Monitored retrievable storage capacity was included to provide a buffer storage between fuel shipment from reactor and emplacement of disposal packages in the geologic repository. As originally planned, this would have allowed DOE to began accepting fuel from utilities in 1996

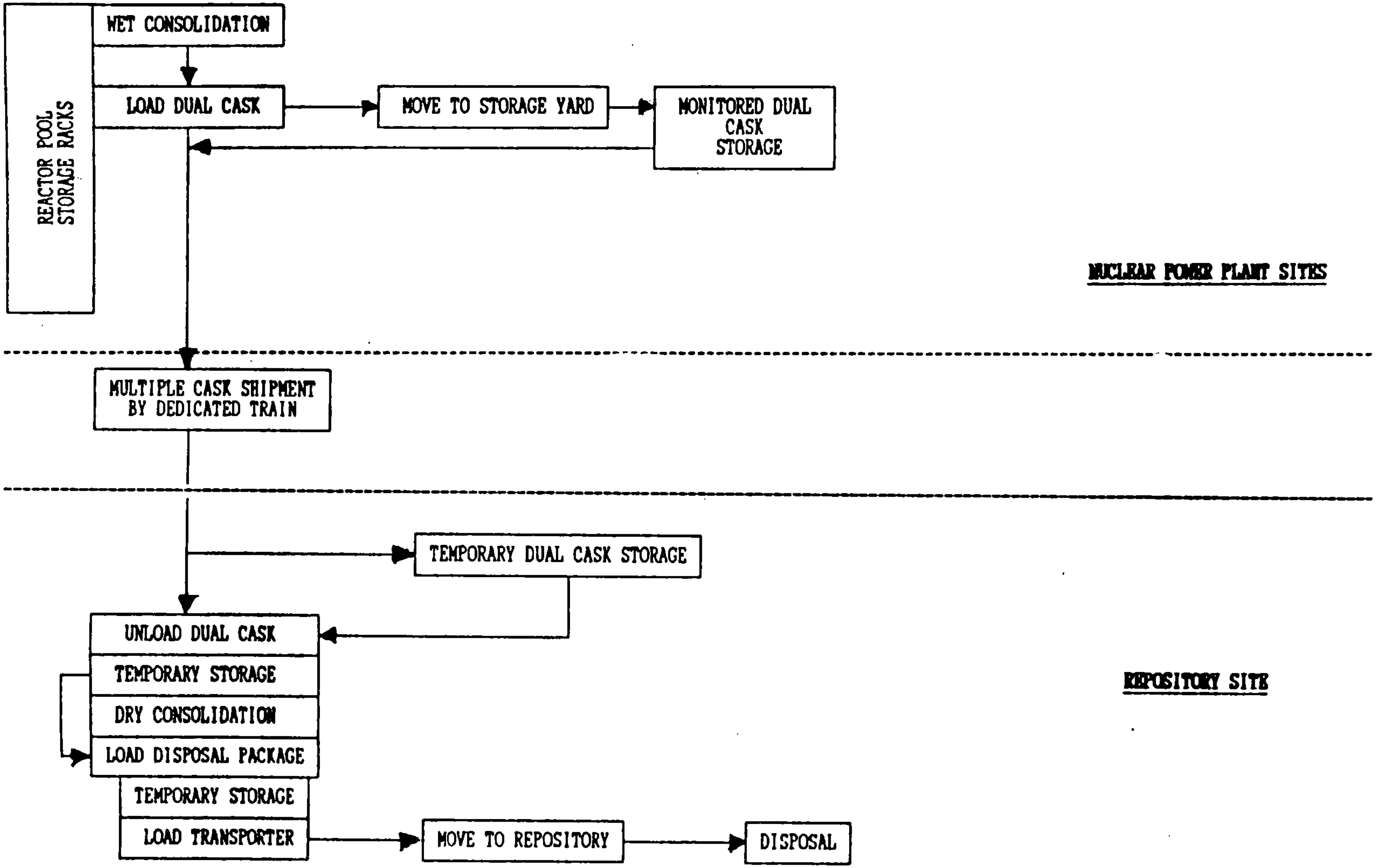


FIGURE IV.3 - INTEGRATED DUAL PURPOSE CASK (I-NO-MRS) SYSTEM CONFIGURATION FLOW CHART fulfilling their contractual obligation to start accepting fuel by 1998. When DOE revised their mission plan to delay the initial repository operation, by five years, until 2003, planned MRS operation was delayed until 1998

Fuel processing and storage operations at the I-MRS would be regulated by NRC under 10 CFR 72. MRS operation would be initially licensed for 40 years with provision for renewal. After completion of its mission, the I-MRS site would be decommissioned and the site prepared for unrestricted use. Several important changes have been made in the original concept including:

1. Linking receipt of fuel at the I-MRS to NRC granting a construction permit for the first repository and limiting storage at the I-MRS to 15,000 MTU to alleviate local concern that the I-MRS would become a de facto repository. When the Congress authorized the MRS in 1987 the linkages on the use of the MRS was made more restrictive, Construction of the MRS can not began until NRC issues A license for construction of a repository, not more than 10,000 metric tons of fuel can be stored at the MRS prior to start of repository operation, and acceptance of fuel at the MRS is prohibited during any time the repository license is revoked by NRC or construction of the repository ceases. This in effect places MRS operation on essentially the same schedule as the repository operation.

2. Packaging fuel in an intermediate package at the I-MRS

for storage and transportation which would be overpacked at the repository with the disposal package (which is yet to be defined).

3. Shipment of fuel from western reactors directly to the repository for packaging in preparation for disposal.

It is anticipated that there will be additional refinements particularly in packaging since there appears to be some inconsistencies between current storage, transportation, and disposal package reference designs. The following I-MRS concept system description is based on information from DOE's proposal to Congress.

<u>At-Reactor Storage</u>

The at-reactor options available and the manner in which they would be applied are assumed to be identical to DOE's No-MRS concept.

<u>From-Reactor Transportation</u>

The transportation system assumed for shipment of fuel from reactors is the same as DOE's No-MRS concept except fuel from western reactors would be shipped directly to the repository and the balance shipped to the I-MRS. (About 10 percent of the fuel would be shipped directly to the repository.) The transportation system for moving fuel from the I-MRS is discussed below as a separate sub-system.

I-MRS FACILITY

It was originally assumed that the I-MRS would start accepting fuel in 1996 and reach full capacity of 2,500 MTU per year in 1998. The revised plans have pushed these dates back two years and linkages in 1987 NWPA amendments essentially delays operation of the MRS to the start of repository operation. Fuel would be received at the I-MRS from reactors by rail and truck. Fuel would be unloaded from transportation cask into a dry hot-cell environment and placed in temporary dry vault storage. Intact fuel assemblies would be removed from storage and consolidated remotely behind thick concrete shielding walls. Consolidated fuel would be placed in sealed stainless steel canisters of uniform size and placed in temporary dry vault storage. An inert cover gas would be used in the canister to assure that there is no significant degradation of the fuel during storage. Non-fuel bearing scrap from the consolidation operations would be compacted and similarly packaged for storage and shipment to the repository for disposal or perhaps be segregated for disposal as low-level waste in a regional low-level waste disposal facility. The I-MRS would also have the capability to encapsulate fuel into disposal containers if this step proves to be more efficient than at the repository. Fuel and scrap canisters would be removed from temporary dry vault storage and loaded into special I-MRS transportation casks for shipment to the repository or would be loaded into concrete casks for monitored retrievable storage at the I-MRS facility. DOE has chosen a metal lined reinforced concrete cask that would be manufactured at the I-MRS site as the preferred method of monitored retrievable storage. These casks would weigh up to 220 tons and would measure about 12 ft. in diameter and range from 17 ft. to 22 ft. in height. These casks would be stored on concrete pads in a large storage yard within a fenced security area. Provision would also be made to store dual purpose cask that might be used by utilities. For on-site storage, the mechanically sealed cask would then be moved to the storage area and placed on a concrete pad. Storage of the fuel would be monitored until it can be shipped to the repository at which time the cask would be moved back to the packaging plant and the fuel would be removed and placed back in temporary dry vault storage in preparation for shipment.

I-MRS to Repository Transportation

DOE assumes a highly optimized transportation system based on multiple cask shipment by dedicated train for shipping fuel from the I-MRS to the repository for disposal. It is assumed that 5 large fuel casks are in each shipment. These casks would weigh about 150 tons and are assumed to have a capacity of 21 MTU to 38 MTU depending on repository geologic media (it is not clear how cask capacity is dependent on geologic media if a standard uniform intermediate package is prepared at the I-MRS).

Repository

Repository operation is currently assumed to begin in 2003 with receipt of fuel and scrap canisters from the I-MRS by dedicated train. The canisters would be remotely unloaded from the special transport cask into a hot-cell and placed in temporary dry vault storage. Fuel canisters would be removed from storage and encapsulated in an repository overpack container which is placed in temporary dry vault storage to await emplacement in the repository. Repository disposal container design has not been finalized. When in full operation the repository is assumed to receive 3,000 MTU of fuel per year including fuel from western reactors. Western reactor fuel would be received in standard transport casks by rail and truck would be unloaded, stored, consolidated and canistered in the same manner as larger scale operations at the I-MRS or the fuel would be packaged intact for disposal. Any non-fuel bearing scrap would be compacted and canistered in a similar fashion for disposal. Fuel disposal containers would be remotely transferred from storage and loaded from a hot-cell into a transporter that moves the container to the repository for emplacement. Canisters of non-fuel bearing scrap would also be placed in the repository for disposal.

C. THE INTEGRATED DUAL PURPOSE (I-NO-MRS) CONCEPT

The flow chart for integrated dual purpose(I-No-MRS) spent fuel management system concept is shown in Figure IV-3. This system configuration design is based largely on ideas developed at the Tennessee Valley Authority (5, 6, 8) which were refined in DOE's

Westinghouse PRDA project (9) and by the State of Tennessee's evaluation team (1, 7) in the course of reviewing DOE's MRS Need and Feasibility Study. The I-No-MRS concept uses dual purpose cask integrated physically and institutionally into at-reactor storage, transportation and repository operations to provide flexibility and reliability and to minimize fuel handling. The universal cask concept (8, 9) in which the cask would also be used a disposal container is compatible with the dual purpose cask concept up to disposal and is also an attractive basis for system integration. This concept has not been developed to the point where expected repository performance is well understood. Therefore, with current uncertainties, greater confidence can be placed on a dual purpose cask system. Any comprehensive evaluation of alternative system configurations should include the universal cask concept, but is beyond the scope of this study.

A family of standardized dual purpose cask suitable for storage and transportation are utilized for at-reactor storage in conjunction with rod consolidation and concrete storage modules to provide efficient flexible at-reactor storage. Due to their functional similarity, only dual purpose cask use is depicted in the flow chart. Standard dual purpose casks would be made readily available allowing utilities to utilize them for long term at-reactor storage and/or as a temporary portable full core reserve permitting better utilization of available pool storage. DOE would provide incentives to utilities to encourage at-reactor rod consolidation to improve the effectiveness of pool storage and the use the dual purpose cask for storage and transportation. Dual purpose casks would be designed for 10 years old fuel and would be available in up to five standard sizes ranging in nominal loaded gross weights of 25 to 150 tons. DOE would work with individual utilities to upgrade access and cask handling facilities to accommodate the largest cask practical. In some cases a special transfer cask might be used to move fuel from the reactor pool to a larger dual purpose cask that cannot be handled inside the plant. DOE would work with utility industry groups to establish fuel acceptance criteria and packaging standards as soon as possible eliminating the non-standard fuel classification from DOE/utility contracts.

Multiple cask shipments would be made periodically by dedicated train with special crews under conditions that provide full control over all aspects of spent fuel transportation to the repository. Barge or heavyhaul transfer would be used, as appropriate, to move large cask to a nearby railhead where the plant does not have rail access and it is not practical to provide rail access. Upon receipt at the repository the dual purpose casks could be utilized for temporary buffer storage and would be reused for fuel transport once shipment to the repository begins.

There is a real possibility that the start of large scale disposal will be delayed beyond the time when it becomes desirable to decommission nuclear power plant sites. This could begin to become a pressing problem by the about year 2020 if

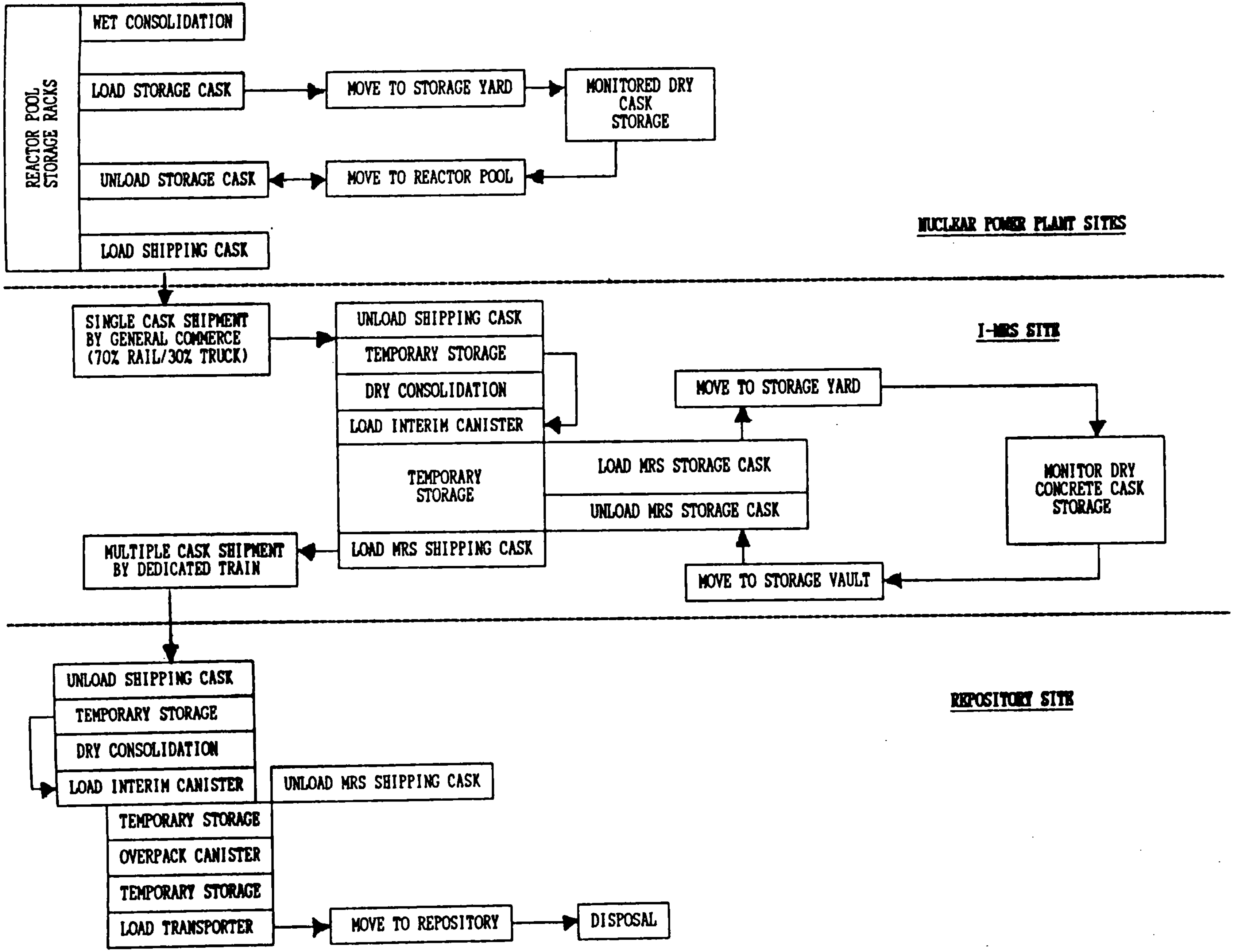


FIGURE IV.2 - DOE'S I-MRS SYSTEM CONFIGURATION FLOW CHART decommissioning should begin within ten years of the end of commercial operation of a nuclear power plants. In this event, the fuel could be shipped in the dual purpose cask to one or more centralized monitored retrievable storage sites to accommodate decommissioning until the repository is ready for operation. This type of MRS would be simple buffer storage with no processing or packaging of the fuel at the MRS site. Since it is not necessary to return dual purpose cask to the reactor pool to transfer the fuel to transport casks dual purpose cask can be use for at-reactor storage after the pool is not available. It is not necessary to open the dual purpose case before shipment from the reactor or from a simple buffer MRS if one should become desirable. It would not be necessary to make the decision to include this form of MRS as part of the system until after the turn of the century when better information on the prospects for repository operation is available. It, however, is important to recognize the flexibility available in the I-No-MRS system to use this option if it becomes necessary or desirable.

Dual purpose cask would also be used to provide buffer storage of spent fuel at the repository site as well as buffer storage of disposal packages to accommodate normal perturbations in repository operation or major disruptions the balance of the waste management system to continue in operation. This I-No-MRS system is not dependent upon any firm repository schedule or continuous repository operation, providing great flexibility in overall operation of the waste management system. Since large scale disposal is not likely to begin before 2008 or later, the repository could designed to accept 20 year old fuel rather than the current design basis for 5 year old fuel. This could simplify system design, reduce impacts and increase the capacity of the repository as well as reduce disposal cost.

At-Reactor Storage

It is assumed that utilities store spent fuel at their reactor sites until the repository is ready to accept fuel for disposal. Subject to modification by mutual agreement, shipments to the repository are to be based on the oldest fuel first. It is assumed that utilities will rerack storage pools to the extent practical and provide additional storage as needed by rod consolidation and/or modular dry storage. In some instances fuel may be consolidated and placed directly into dual purpose casks or concrete storage module canisters. Intact fuel assemblies or previously consolidated fuel would be placed in at-reactor dry storage as the need arises. Fuel would be loaded into dual purpose casks in the reactor pool, water would be removed and the fuel vacuum dried, then backfilled with inert gas. The cask would then be decontaminated and moved to the storage yard or turned over to DOE for shipment as appropriate. Where the utility elects to use a standardized fuel canister containing consolidated or intact fuel in conjunction with concrete storage modules, the dual purpose cask would be used to transfer the canister to the storage module. Standardized concrete storage module canisters would be shipped to DOE in dual purpose casks without returning the fuel to the reactor pool, as would also be the case for dual purpose casks used for storage.

Transportation

All fuel would be shipped to the repository by dedicated train in dual purpose casks. The number of casks in each shipment would be as large as practical consistent with reactor operation and transportation logistics. In some cases all the fuel stored at a reactor sight might be shipped in single campaign after the reactor has retired from service. The largest cask consistent with cask handling and loading would be used. Where the plant does not have rail access, large casks would be moved to a nearby railhead by barge or heavy haul vehicle. DOE transportation contractors would provide dedicated transport equipment and special crews trained to provide all necessary transportation functions including security and emergency response. This type of shipment can also easily accommodate any special routing or administrative controls that DOE, NRC, or DOT may find necessary or desirable to alleviate public apprehension about spent fuel shipment.

Repository

Spent fuel would be received at the repository in dual purpose casks which would be retained in a temporary holding area until ready to be unloaded. These casks would also serve as a temporary buffer storage at the repository to provide flexibility in packaging operations and decouple reactor shipment from emplacement of fuel in the repository. Spent fuel packaging operations at the repository would be essentially the same as those performed at the MRS in DOE's No-MRS concept. However, if there should be a temporary disruption in repository emplacement operations, dual purpose cask would also be used to store disposal packages avoiding disruptions in the rest of the system. Dual purpose casks would be decommissioned with the repository when they are no longer needed. The casks would be decontaminated and the materials salvaged if practical or disposed of at a low-level waste facility.

2. DISCUSSION OF SYSTEM CONSIDERATIONS

The following is a discussion of several key assumptions, important system characteristics and the systems environment.

A. DOE's NO-MRS Concept

DOE's NO-MRS system configuration is based on a set of inflexible at-reactor storage and traditional transportation assumptions based on concepts developed over twenty years ago for shipping spent fuel to reprocessing plants. DOE assumed that all shipments are to be made by single cask shipment by truck or rail in general commerce. Shipment is assumed to be by rail (70%) where the plant has rail access and the remainder is shipped by truck (30%). These might be appropriate when the objective was to get 180 day old fuel reprocessed and recycled as quickly as possible and the main consideration in optimization of the transportation system was to minimize cask leasing charges. The rail and truck cask capacities assumed for from-reactor shipment were 5.6 MTU and 0.9 MTU, respectively. This results in about three times more truck shipments than rail shipments over a nominal average distance to the repository of about 2000 miles compared to the average distance of about 800 miles to the I-MRS based on a central eastern location similar to the Oak Ridge, TN. site.

In their proposal to the Congress DOE examined alternative improvements in their assumed NO-MRS concept that align with equivalent improvements obtained by deploying an I-MRS facility. These were:

- o Expanded lag storage at the repository to provide a buffer between waste acceptance and waste emplacement.

- o Expanded storage at reactor sites, either by adding modular dry storage or in-pool consolidation of spent fuel, to provide contingency storage if repository operations were delayed.

- o Use of larger shipping cask and multi-cask shipments, thereby increasing the tonnage per shipment and reducing the number of discrete shipments.

DOE evaluated these only in terms of how they can achieve similar effects to the I-MRS and concluded that some of them could potentially improve individual aspects of the No-MRS system but no single improvement or combination of the improvements provides the same total system performance improvements as deploying the I-MRS. The analysis on which DOE based this conclusion was superficial and highly subjective. No effort was made to take a systems approach to integrate these elements as an effective NO-MRS system. The NO-MRS option considered by DOE for comparison with DOE's I-MRS concept appears to selected largely to facilitate justification of DOE's proposed I-MRS.

B. DOE's I-MRS Concept

Including an I-MRS as a part of the waste management system would eliminate the need for Federal Interim Storage (FIS) unless circumstances arise, which seems likely, that would prohibit or limit storage at the I-MRS. Use of FIS at a central facility could also be vulnerable to some of the same potential problems as access to an I-MRS facility. FIS is currently limited to 1,900 MTU of fuel, which must be moved to the repository within three years of initial repository operation. This greatly reduces FIS flexibility in dealing effectively and reliably with spent fuel management uncertainties. It appears that utilities would, if possible, opt for some form of at-reactor before relying on FIS. The I-MRS concept proposed by DOE does not directly correspond to any of the concepts considered in the NWPA. This, however, is not to say that the proposed I-MRS is inconsistent with the NWPA since Congress asked DOE to define the function of the MRS in its proposal. The storage function in the proposed I-MRS is intended by DOE to serve as a buffer for nominal delays rather than as an alternative to a repository. Some observers believe that building a geologic repository in a reasonable amount of time is unlikely and the I-MRS is the only vehicle by which something can be done to show some progress. How this represents progress is not clear. Part of the spent fuel would be moved to a central location when where basically the same dry storage technology would be used and most of the fuel would remain at the reactors.

While the NWPA sets the objective of starting geologic disposal by 1998, it is clear that utilities have the responsibility to provide interim storage until DOE accepts the waste for disposal. Several NWPA provisions, however, are not clear on whether interim storage at an MRS should be paid for from the Nuclear Waste Fund or by individual generators or owners in accordance with their use. DOE proposes to fund the MRS from the Nuclear Waste Fund requiring all nuclear waste generators or owners to pay for the facility without regard to their actual use of the facility. Some utilities find this feature objectionable and would prefer to see the MRS funded only by those that elect to use it. The MRS in this instance simply becomes essentially the same as FIS and would not likely be used by any utility unless they have no other alternative available.

DOE concluded in their proposal to Congress that by emphasizing system integration in optimization of the overall waste management system with an I-MRS, several important program objectives can be enhanced compared to the DOE NO-MRS system. DOE's claimed improvements include:

- Improved transportation efficiency because consolidation and packaging at the I-MRS would reduce the number of shipments to the repository with concomitant reductions in potential environmental impacts and risks to the public.

- Increased reliability and flexibility in operating the system in an integrated cost-effective manner by incorporating the I-MRS which can regulate the flow of waste to the repository.

- Improved confidence in beginning to accept quantities of waste no later than January 31, 1998.

- Ability to accept significantly larger quantities of waste earlier, substantially reducing the added cost to utilities of providing increased at-reactor storage.

- Ability to focus repository licensing efforts on demonstrating the long-term isolation capability of the site because many of the operational functions (i.e., waste preparation) would be handled at the I-MRS.

DOE assumes that shipment from the I-MRS to the repository is by a highly optimized transportation system appropriate for shipment of amount and not the kind of activities that must be conducted at the repository.

DOE claims of reliability and flexibility for the I-MRS depend on everything working out to fit their scenario. Based on past experiences this seems unlikely. There are several very creditable scenarios by which storage at an I-MRS could be restricted:

- o The linkages that the Congress placed on the MRS in the 1987 NWPA Amendments virtually eliminates the repository schedule benefits and DOE's ability start accepting fuel from utilities by 1998 for off-site shipment. It would be possible to meet DOE's proposed 2003 repository schedule only if everything falls in place without delays. Most knowledgeable observers seem to agree that a significant delay is likely. Under these conditions it would not be prudent for utilities to depend on DOE taking their fuel and will find it necessary to go ahead and make the investments necessary for expanding at-reactor storage.

- o In the unlikely event that the Congress should approve an I-MRS without the linkages it does not appear likely that there would be a working consensus in support of the I-MRS configuration as proposed by DOE. Under these conditions it is quite possible that the project would encounter extensive delays due to legal maneuvering, regulatory intervention, and political pressures that can be brought to bear by MRS aged fuel for disposal. This optimized system assumes the use of dedicated train shipment of five large cask that have capacity in the range of about 21 MTU to 38 MTU each depending on repository media. Typically the average distance from an eastern MRS to the repository is about 2000 miles. The transportation benefits claimed by DOE for the I-MRS are largely due to the assumed differences in efficiency in the transportation systems in terms of trip-miles (10). While trip-miles has some importance as a measure of public perceptions of apparent transportation activity, it has little value as a measure of economic, environmental or safety impacts of transportation. Including an eastern I-MRS in the system actually increases the most fundamental measure of spent fuel transportation, in terms of metric ton-miles of spent fuel shipped, by about 40%. The claimed transportation benefits of DOE's I-MRS concept are due primarily to improved transportation between the MRS and repository made possible by fuel consolidation at the MRS and multiple cask shipment of large casks by dedicated train. However, greater reductions in transportation impacts can be achieved by deploying a similarly improved transportation system for direct shipment from reactors to the repository.

The extent to which an I-MRS will reduce at-reactor storage needs is highly speculative since it may not be prudent for of utilities to forgo being prepared to provide on-site storage by relying on storage at the I-MRS. Since DOE plans on shipping western fuel directly to the repository, the licensing relief claimed for the I-MRS is questionable since there is only a difference in the opponents. The Clinch River Breeder Reactor(CRBR) project is a good example of the delays and waste of resources that what can result when a working consensus does not exit.

- The effectiveness of the I-MRS is dependent entirely on the ability to ship fuel from reactors to the I-MRS. Therefore, its use is vulnerable to delays or disruptions in transportation. There appears to be considerable concerns by the general public and officials of states through which the fuel must be transported about the risk related to transportation. Some utilities, environmentalists and other public interest organizations seem to be of the opinion that unnecessary transportation of spent fuel should be avoided (11). While it is possible that Federal supremacy will eventually be established over all matters pertaining to spent fuel transportation, it is not evident that it will be done quickly. This could delay acceptance of fuel at a MRS or repository requiring utilities to be prepared to accommodate expanded on site storage.

- DOE proposes to limit storage at the I-MRS to 15,000 MTU to assure that the MRS does not become a de facto repository. This is most likely to come into play if there is a delay in the repository program and would probably come into effect in the 2015 to 2020 time frame when most of the reactors currently in operation may be retired from commercial service. This could force utilities to continue expanding at-reactor storage since they would not have access to storage at the I-MRS.

In the original I-MRS concept DOE assumed that spent fuel would be disassembled and consolidated before placing the fuel in the disposal container prior to emplacement in the repository. The theory was that such consolidation would be cost effective in reducing disposal cost. The dry consolidation process that DOE proposes to use is the most complex and least proven technology associated with spent fuel management up to placement in the repository. This process is also increases the potential for accidents and can be source of additional waste production. Without rod consolidation fuel packaging at the repository for disposal would be relatively simple and would go along way towards taking licensing and construction of surface facilities off the critical path for getting the repository in operation. It has never been apparent that the decision to consolidate fuel for disposal was well justified. Studies have been recently completed, but have not been released by DOE, that indicate that consolidation can not be justified based on the disposal benefits in the repository (12). Elimination of rod consolidation would greatly simplify spent fuel packaging operation at I-MRS and would reduce the efficiency of MRS dry storage as well as much of the transportation benefits attributed to having an I-MRS in the system. Therefor, by elimination of rod consolidation at the I-MRS and/or repository a large part of the potential benefits of an I-MRS in the system is eliminated. This, however, would not eliminate the benefits of at-reactor rod consolidation. The system benefits of rod consolidation are greatest when performed at the reactors.

From the preceding discussion it is seen that the I-MRS system configuration concept as proposed by DOE is very fragile both institutionally and technically. It does not have the ability to perform effectively and reliably under the wide range of uncertainties and circumstances under which it might need to perform. The concept is so vulnerable that it is very difficult to define the exact functions of the I-MRS and how it will interface and interact with other components of the overall waste management system.

C. The I-NO-MRS Concept

The use of dual purpose cask as described in the I-NO-MRS concept provides an effective and reliable means of providing interim storage at-reactor sites that is less vulnerable to disruption than storage at an I-MRS or FIS. The spent fuel generated at reactors must be stored, and passive storage in dual purpose casks provides the greatest flexibility in accommodating the many uncertainties while minimizing the risk related to handling, storing, and transporting spent fuel. A family of dual purpose (storage and transportation) casks is the principal interface between reactor pool storage and disposal rather than the centralized packaging facility proposed by DOE. These dual purpose casks could be fully integrated into the overall system to provide a higher degree of flexibility and reliability with regard to:

- Providing wet and/or dry storage of intact or consolidated storage at reactor sites.

- Reducing at-reactor fuel handling since it is not necessary to move these casks back into the reactor pool to remove the fuel and load it into transport casks.

- Serving as a portable full core reserve allowing increased storage in reactor pools.

- Providing long-term at-reactor storage after the reactor and pool have been decommissioned, if necessary.

- Substantially reducing from-reactor transportation costs and radiological dose commitments (occupational and public from routine operations and accidents) by making multiple cask shipment by dedicated train.

- Reducing state and public concerns by more effective security, control, and emergency response made possible by use of dedicated trains for spent fuel shipment.

- Preserving the option for simple buffer MRS facilities to allow decommissioning of reactor plant sites if there is an extended delay in the availability of a geologic repository. The dual purpose cask would in this event be moved to one or more central locations where they would continue to provide monitored dry storage until shipped to a repository. This would not involve removing fuel from the cask.

- Providing temporary buffer storage of spent fuel at the repository site to facilitate optimum fuel flow to the packaging facility and continued operation of the transportation system when there are disruptions in packaging or disposal operation.

- Providing temporary buffer storage between packaging operations and disposal if there are disruptions in disposal operations.

The number of dual purpose casks in the system would depend largely on the amount of dry storage needed at reactors which depends on when large-scale geologic disposal begins. The beginning of large-scale disposal is likely to be delayed at least ten years beyond the 1998 target date set in the NWPA and it is anticipated that there would be an adequate number of dual purpose casks in the system. They would be used initially for storage and would become the transportation fleet and buffer storage at the repository when the repository starts operation. The family of casks would consist of up to five standard sizes designed to accommodate BWR or PWR fuel with a removable fuel basket. DOE could provide incentive credits based on sharing avoided system cost to encourage utilities to consolidate fuel and to use the largest cask practical to meet their storage needs. Responding positively to these incentives will be important to utilities since they must show their public utilities commission that they have acted prudently if they are to be allowed to recover their storage cost. It is important to have some leverage to encourage utilities to act in the ratepayers interest.

DOE could develop a competitive supply system for standard dual purpose casks and make volume purchases to obtain the benefit of mass production. DOE could lease these casks to utilities based on cask investment interest cost. Utilities should pay all other at-reactor storage costs for facilities and operations. Dual purpose casks would also be designed to interface with concrete storage modules using standardized fuel canisters allowing utilities to also use concrete storage modules for at-reactor dry storage. The dual purpose cask would be used to transfer a canister to the storage module and to ship it to the repository without returning fuel to the reactor pool.

The dual purpose cask can be readily adapted to provided at-reactor FIS at utility expense or Federal financed at-reactor storage if Congress determines such assistance is desirable. In this case DOE would provide utilities with standard dual purpose without lease charges. DOE would not be involved in conducting any activities at the reactor site. DOE could, however, go as far as paying for the cask storage facilities and reimbursing the utility for related operation cost. This would not be different in principal than paying a contractor to operate a centrally located I-MRS. It, however, probability is not desirable to remove all incentives for utilities to keep some pressure on DOE to get the repository in operation.

It is important to note that the dual purpose cask system concept assures that no reactor will be forced to suspend operation due to lack of storage, or inability to ship fuel to an MRS or repository. Repository siting, characterization, selection, licensing and construction can proceed at the pace required to do-it-right taking fuel acceptance off the critical path to repository operation.

The integrated dual purpose (I-NO-MRS) system configuration has been shown to be very robust with regard to its flexibility to perform effectively and reliably under a wide range of institutional and technical uncertainties in the overall waste management program.

3. ADEQUACY OF UTILITY STORAGE CAPABILITY

The question naturally arises as to the ability of utilities to provide at-reactor storage if there should be an extended delay in the first repository. Utilities that have not yet done so can in most cases substantially increase in-pool storage capacity by using high density poison storage racks. Rod consolidation and other options to further expand in-pool storage is technically feasible where pool structures can carry the additional loads. Rod consolidation has not yet been established as a mature technology, but there does not appear to be any barrier beyond making the investment required to obtain the experience necessary to achieve maturity. Current information suggests that a mature rod consolidation technology would provide the lowest cost option for expanding at-reactor storage where it can be used.

Dry cask storage and concrete storage modules has been demonstrated and licensed by NRC for at-reactor use in casks that are essentially the same as the dual purpose cask proposed for the I-NO-MRS alternative. Dual purpose casks would of course need to be certified by NRC for transportation. The differences in current storage casks and dual purpose casks are not believed to be significant, and the principal barrier to designing, developing and certification is making the necessary investment. It is anticipated that standardized dual purpose casks produced in large volume in a competitive market would be significantly lower in cost than transportation casks or a large number of different storage cask designs.

It can be concluded that utilities taking prudent action to provide for their own at-reactor storage needs are unlikely to run any real risk of being forced to suspend reactor operation for lack of at-reactor spent fuel storage capacity. The NWPA also provides for up 1,900 MTU of Federal Interim Storage (FIS) to meet the needs of any utilities that demonstrate to NRC that they cannot provide at-reactor storage. The cost would be allocated equitably to users on a prorated basis. DOE has deferred selection of a site or storage technology until there is a clear need for FIS and DOE does not anticipate a need for FIS. As required by the NWPA, DOE prepares an annual report addressing the need and fees related to FIS. To date, no utility has applied for FIS.

The quantity of spent fuel that utilities will be required to provide for storage outside the reactor storage pools depends on the following parameters:

1. The quantity of fuel that will be produced which is dependents on nuclear plant performance and useful service life as well as fuel burnup achieved,
2. The efficiency the utility can achieve in utilizing at-reactor pool storage space through using improved storage rack designs, better space utilization, consolidation efficiency, and other resourceful innovations, and
3. When and at what rate DOE starts accepting fuel for shipment off site.

There is a great deal of uncertainty in all of these parameters which contributes to a wider range of uncertainty in at-reactor dry storage requirements.

Over the years DOE has consistently over estimated nuclear capacity projections and related spent fuel production. While

DOE's current estimates are more realist than those of a few years ago they are still overly optimist in view of the current outlook for nuclear power in this country. The following probabilistic estimate of cumulative spent fuel discharges through the years 2003, 2008, and 2020 is believed to realistically represent the uncertainty in spent fuel generation (13).

TABLE IV.1 - UNCERTAINTY IN SPENT FUEL PRODUCTION FORECAST

CUMULATIVE * PROBABILITY PERCENT	CUMULATIVE PRODUCTION 1000 METRIC TONS		
YEAR	2003	2008	2020
2.5	42.0	46.9	52.3
15.0	43.6	51.7	62.3
50.0	45.4	56.3	73.5
85.0	47.6	58.3	80.2
97.5	48.5	59.6	96.4

* probability that spent fuel production will be less than or equal to the indicated amount.

The mean or expected value of cumulative spent fuel generation by the year 2020 is slightly larger than the capacity authorized in the NWPA for the first repository not including defense waste.

Utilities have consistently underestimated their ability to provide spent fuel storage based on their response to surveys. There are a number of factors which contribute to this. They generally report only on what they are authorized to store not what they could do if necessary. They also would like to keep pressure on DOE to carry out the governments obligations. If a utility were faced with the real prospects of being forced to shut down a reactor because of the lack of storage space it is anticipated they would exhibit considerable resourcefulness in expanding storage capacity as they have in the past.

As previously noted, there does seem to be a general consensus by most informed observers that repository operation is likely to be delayed beyond DOE's current 2003 schedule. A quantitative estimate of the expected duration of the delay is not available.

3. NRC REGULATORY CONSIDERATIONS

Expansion of at-reactor pool storage by using high density storage racks and/or rod consolidation generally entails amending the nuclear plant facility license under 10 CRF 50 to increase storage capacity. Applications for amendments will be considered on a case by case basis, and NRC has routinely approved properly supported applications for intact and consolidated fuel.

Dry at-reactor storage in storage only or dual purpose casks or storage in concrete cask at the I-MRS would be licensed under 10 CFR 72 regulations pertaining to independent spent fuel storage facilities. This is a materials license rather than a facility license which permits a single step licensing process. At-reactor dry storage in metal casks has been licensed by NRC at Virginia

Power Company and Carolina Power & Light Company nuclear plants. NRC is initiating proceedings, based on this and other experience to promulgate a rule as provided in the NWPA, to approve the use of dry storage cask for use at nuclear plant sites to the maximum extent practical without the need for site specific approval. It is anticipated that the rule will result in NRC certification of cask designs for storage similar to the process of certification of cask for transportation. This process would be applicable to storage only or dual purpose casks recognizing that a dual purpose cask must also be certified for transportation. Transportation or dual purpose cask would be certified by NRC under provision of 10 CFR 71.

Generally the NRC promulgates regulations as they are needed to assure public safety. The current regulations have been developed over a number of years in a compartmentalized fashion to deal individually with operation of reactors, operation of fuel preparation facilities, transportation of radioactive materials, and for the storage of spent nuclear fuel. Each set of these regulations appears to be adequate to provide for accepted standards of public protection when applied independently to their respective component of the spent fuel management system. This can, and does in the case of DOE's I-MRS concept, result in the situation where radiological dose commitments are much greater from the sum of the individual components of the system than for a system that is designed as system to minimize radiological dose commitments. In fact, some very conservative aspects of the regulations which were intended to deal with other circumstances can when applied to one component to obtain marginal improvements can force conditions in other components that result in much greater dose commitments in the overall system than the marginal reduction achieved in the individual component. This is the classical situation that justifies the use of the "systems approach" to designing a system. NRC's responsibility to the public, however, is to keep the radiological dose commitment for the whole waste management system as low a reasonably achievable (ALARA). NRC presently does not have an effective mechanism for integration and optimization of waste management system from an overall safety standpoint. The current partitioned approach is counter productive in achieving this objective and NRC needs to take a "systems approach" to carrying out their responsibility to the public. NRC has traditionally taken the approach that it not their responsibility to propose how something should be done but to dispose of specific proposals that the licensee proposes. Under this approach NRC is relying on DOE and the utilities to somehow put together an overall system configuration which NRC can regulate piecemeal that will fulfill NRC's responsibility to the public. NRC has recognized, as indicated in their comments on DOE's report "Initial Version: Dry Cask Storage Study" that it is not happening and has pushed DOE for compatibility in spent fuel cask designs for storage and transportation. Cask compatibility is an important aspect of the overall problem but is only the tip of the iceberg. NRC is aware that there does not appear to be anyone in charge but appears to be reluctant to take the initiative to provide leadership in integration of the spent fuel management system components to achieve overall system ALARA dose commitments. NRC is not likely to take an integrated systems approach to regulation of the waste management system unless DOE formally proposes to use multipurpose cask that cut across traditional internal NRC regulatory boundaries or public pressure placed on NRC. Opportunities for public participation in NRC regulation of the spent fuel management system up to the repository may be very limited since it will be conducted largely through materials handling licensing and cask certification that do not provide for the type of intervention available for facility licensing.

5. REFERENCES

1. Raymond E. Hoskins, U of TN, "Status of Spent Fuel Management Technology Related to DOE's Monitored Retrievable Storage Proposal", Waste Management Research and Education Institute", April 1987.

2. DOE, "The Need for and Feasibility of Monitored Retrievable Storage--A Preliminary Analysis", DOE/RW-0022, April 1985.

3. DOE, "Monitored Retrievable Storage Submission to Congress", Volume I-III, DOE/RW-0035, March 1987.

4. DOE, "Draft Mission Plan Amendment", DOE/RW-0128, January 1987.

5. Raymond E. Hoskins, TVA, "Integrated Cask Storage Systems for Storage, Transportation, and Disposal of Spent Nuclear Fuel", Waste Management '84 Conf., March 1984.

6. Raymond E. Hoskins, TVA, "A TVA View of Spent Fuel System Integration and Optimization", 3rd International SFST Symposium/Workshop, April 1986.

7. U of TN, etc, "Evaluation of the Need, Feasibility, and Siting of the MRS in Tennessee", Waste Management Research and Education Institute, December 1985.

8. Raymond E. Hoskins, TVA, TVA Systems Study: A Parametric Study of the Potential for Spent fuel Transportation System Optimization", INMM Conf., January 1986.

9. Westinghouse and TVA, "Phase 1 Study of Metalic Cask Systems for Spent Fuel Management From Reactor to Repository", WTSD-TME-085, February 1986.

10. Raymond E. Hoskins, U of TN, "Identification of Geographic Areas for Siting a Monitored Retrievable Storage Facility to Minimize Transportation Impacts", Waste Management Research and Education Institute, January 1987.

11. MRS Review Commission Hearings, December 1-2, 1988

12. Paul D. O'Brien, SNL, "The Effect of Rod Consolidation Spent Fuel Disposal Cost", SAND85-2849A, Unpublished.

13 Raymond E. Hoskins, U of TN, "Probabilistic Assessment of Nuclear Waste Fund Fee Adequacy", Waste Management '88 Conf., March 1988.

14. Radioactive Exchange, "NRC: DOE Should Push for Compatibility of Spent Fuel Cask Designs", November 21, 1988.

V. EVALUATION OF ALTERNATIVES

The systems approach is used to perform an evaluation of a limited number of alternative system configurations for management of spent nuclear fuel from the point of discharge from reactors through emplacement in a geologic repository for permanent disposal. The systems approach involves the use of specified criteria to design, optimize, and evaluate alternative system configurations to perform a clearly defined mission in terms of the customers values for the environment in which the system is to function. The preceding chapters of this report: provides background information on the systems environment, discusses the systems approach, defines the system mission, identifies the customer for the system, describes the customers value criteria, and delineates the three alternative system configurations that are addresses in this evaluation.

While the ultimate customer for the system is the public it was found that there is hierarchy of stakeholders whose acceptance if not support is necessary for successful implementation of a waste management system. There is a correlation between the importance of the individual stakeholders values and values of the public. Generally, the closer the stakeholder is in contact with or accountable to the public the more important are that stakeholders values.

The 1987 amendments to the Nuclear Waste Policy Act (NWPA) of

1982 establishes a Monitored Retrievable Storage (MRS) Review Commission to review the status and adequacy of the Department of Energy's (DOE's) evaluation of the systems advantages and disadvantages of the MRS facility that has been proposed (1) by DOE. The Commission is required to evaluate the utility of the MRS from a technical perspective and make a recommendation to Congress as to whether such a facility should be included in the national nuclear waste management system. In preparing their report and making their recommendation the Commission is directed to compare DOE's proposed MRS facility to the alternative of at-reactor storage of spent fuel prior to disposal in a repository.

Previous chapters of this report reviews the status and adequacy of DOE's approach to systems design, optimization, and evaluation. It was found that DOE has not applied a systems approach to designing, optimizing, or evaluating alternative waste management system configurations in arriving at DOE's recommendation to make the proposed MRS an integral part of the waste management system. Moreover, DOE has not taken a systems approach to designing and optimizing a system configuration that effectively integrates at-reactor storage into the overall waste management system. This report describes an Integrated No MRS (I-NO-MRS) system configuration based on integrating a family of standardized dual purpose metal cask designed for at-reactor storage and transportation of spent fuel into the overall waste management system. The MRS Review Commission should include this concept in their comparison of alternative system configurations based on at-reactor storage to DOE's proposed Integral MRS (I-MRS) system configuration. The systems evaluation of alternative system configurations in this study compares the authorized (NO-MRS) and improved (I-MRS) systems configuration concepts as described in DOE's MRS Submission to Congress to the integrated dual purpose cask (I-NO-MRS) system previously described in this report. It is recognized that Congress has subsequently authorized the proposed MRS and the nomenclature used here is simply to maintain consistency with the DOE reference documents.

There is a very large number of possible system configurations that might appropriately be included in the evaluation of alternative system configurations. Due to the limited resources available for this study the alternatives considered was limited to these three concepts. There are, however, two other system configuration concepts that should be included in the MRS Review Commissions's evaluation. These are: the simple storage MRS concept financed only by its users, and the triple purpose or universal cask concept which is similar to the dual purpose cask concept except the cask is also used in the geologic repository as the disposal container. The former concept was suggested to the Commission by the Tennessee Valley Authority (TVA) and is functionally similar to Federal Interim Storage (FIS) provided for in the NWPA. The latter concept has recently been advocated by public interest organizations, state officials, the Nuclear Regulatory Commission (NRC), and utility industry executives (2, 3, 4). Earlier work on the universal cask concept sponsored by TVA, DOE and the Edison Electric Institute (EEI) indicated that the concept showed promise and should be pursued further (5, 6, 7). After DOE initiated their I-MRS concept, support for development of other concepts was terminated.

The three system configurations used in this evaluation are briefly described below:

> <u>DOE's NO-MRS</u> - This concept consist of simple interfacing of the geologic repository to at-reactor storage using a traditional spent fuel transportation system with little or no effective integration of the components. It assumes that at-reactor storage is provided by re-racking to the extent practical augmented as necessary by dry storage using single purpose storage only casks acquired by utilities to meet their particular situation. Transportation of the spent fuel from the reactors to the repository is by single cask shipment in general commerce by rail or truck (70% in 100 ton cask and 30% in 25 ton cask respectively) depending at-reactor cask handling capacity and rail access. Fuel received at the repository would be consolidated and packaged for disposal prior to underground emplacement.
>
> <u>DOE's I-MRS</u> - In the original concept the fuel consolidation and packaging is moved to a separate central MRS facility in the east which includes buffer storage between the reactors and the repository. At-reactor storage and transportation from the reactors using a traditional transportation system is the same as that used in DOE's NO-MRS concept. Fuel would be shipped from the MRS to the repository using multiple cask shipment by dedicated train (nominally five 150 ton cask per shipment). The waste package would be received ready for emplacement at the repository. The final configuration of DOE's I-MRS concept is still in

transition as DOE continues to study whether or not: fuel should be consolidated at the MRS or at all, fuel from western reactors should be shipped directly to the repository or to an eastern MRS, and a repository ready disposal package or interim storage package be prepared at the MRS. In this evaluation it is assumed that all fuel is shipped to the MRS where it is consolidated and packaged for interim storage with a disposal overpack being used at the repository.

DUAL PURPOSE CASK SYSTEM or I-NO-MRS - In this concept a standardized family of dual purpose casks suitable for at-reactor storage and transportation of spent fuel are effectively integrated in the overall waste management system. At-reactor storage is provided through a combination of re-racking and rod consolidation in the reactor storage pools augmented as required by dry storage in dual purpose casks and/or in concrete storage modules appropriate to the particular reactor site situation. A family of standardized 25, 40, 100, 125, and 150 ton dual purpose casks are used. These casks are designed to accommodate intact or consolidated fuel and to transport standardized storage canisters used in compatible concrete storage modules. The largest casks compatible with the reactors cask handling capability is used at individual reactors. These casks are used to make multiple cask shipments of spent fuel from the reactor to the repository by special dedicated trains. Where there is no rail access to the reactor site and it is not practical to provide rail access the cask are to be moved by barge, heavyhaul vehicle, or truck to a nearby railhead, as appropriate, for shipment to the repository. These casks would be reused to move fuel from the reactor pools and concrete storage modules to the repository. Since there would be more dual purpose casks in the system than are needed for the transportation fleet these casks would also be used at the repository for buffer storage. If it should become desirable at some time in the future to move fuel away from reactor sites to accommodate reactor decommissioning the dual purpose casks could be moved to one or more temporary storage sites until they can be shipped to the repository.

These concepts are described and discussed in greater detail in Chapter IV of this report.

The 1987 amendments to the NWPA annulled and revoked DOE's MRS site selection at Oak Ridge, Tennessee and deferred initiation of site selection until after the MRS Review Commission reports to Congress on the need for a MRS facility. Impacts related to the transportation of spent fuel appears to be important in the values of most of the stakeholders. A study (9) conducted for the State of Tennessee indicates that potential impacts related to transportation of spent nuclear fuel and the location of a MRS facility are very sensitive to assumptions made about the efficiency of the transportation system between the reactors and the MRS facility. With the use of a traditional transportation system assumed and being developed by DOE the optimum location of a MRS facility would be in mid-west. With the use of the dual purpose cask transportation system assumed in the I-NO-MRS concept transportation related impacts would be reduced by at least one-half and the optimum location of the MRS facility would be as near the repository as possible. It appears to be desirable to develop and utilize a transportation system similar to that proposed for the I-NO-MRS concept even if it should be decided to include an MRS an integral part of the waste management system recognizing that it would reduce the utility of the MRS facility. For purposes of comparison in this study it is assumed that DOE continues with the traditional transportation approach and an eastern location would be selected for a MRS facility. Since Oak Ridge is, from a transportation standpoint, similar to a site that DOE is likely to select the Oak Ridge site is assumed in making quantitative transportation comparisons in this study.

1. - EVALUATION METHODOLOGY

Consistent with the systems approach, alternative waste management system configurations are compared and evaluated in terms of the value criteria important to the system customer. The following hierarchy of value criteria will be used:

1. Health and Safety
2. Economic
3. Environmental
4. Political
5. Social
6. Fairness
7. Scheduling
8. Flexibility

This value structure is a composite developed in workshops (7) with representatives of Public, Government and Technical interest and is discussed in Chapter III of this report. Technically, in the systems approach alternative system configurations are compared and evaluated separately for each criteria or objective and a balancing of conflicting objectives or trade-off is conducted to arrive at an overall rating or ranking of alternatives. There are many ways in which this might be done and the method used should be appropriate to application and meet with the approval of the customer. Only the first two criterion lend themselves to quantitative comparison and the others must be compared qualitative. The trade-offs between conflicting criteria or objectives is a subjective process that can be strongly influenced by the values of the customer. The general process is know as multi-attribute decision analysis. One approach called multi-attribute utility analysis (10) undertakes to devise appropriate proxy measures or scales to represent the qualitative comparisons which is then used in an interview process to encode the decision makers values by identification of indifference points between the criteria measures from which utility functions for each measure can be developed allowing overall quantitative comparison of alternatives. This process can be very valuable as an aid to an individual decision maker by helping them understand the interaction between considerations and implications of the trade-offs being performed. DOE used this process as input to the top level decision in selecting the three sites to be characterized for the first geologic repository (11). In the early 1980's TVA, in cooperation with the Electric Power Research Institute (EPRI), began experimenting with the use of this methodology as a potential means of helping to address controversial public policy issues such as spent nuclear fuel management (12). This initial effort towards encoding public values to assist in evaluation of alternatives was very promising which led to TVA's organization of a project for DOE in which the forgoing stakeholders value structure was developed (7). DOE canceled the project before it could proceed to the point of developing measures and weighting functions appropriate for use in comparison of alternative waste management system configurations. It was necessary for TVA to abandon a joint project with EPRI to continue this work due to opposition from ACORD. Without continuing representative participation of the stakeholders in the process it would be very presumptuous for the systems analyst to assign weighting functions to the various criteria to achieve an overall quantitative comparison of the alternatives. Therefore, the alternatives will be compared and evaluated for each criteria an no effort will be made to apply any quantitative weighting to the criteria. In the overall evaluation a subjective comparisons of the strengths and weaknesses of the alternatives will be discussed in qualitative terms. The results of the study will then be used to compare DOE's I-MRS concept to the I-NO-MRS concept in terns of the considerations required by Congress in the 1987 NWPA Amendments.

2. COMPARISON BY VALUE CRITERIA

The following is a comparison and evaluation for each of the above value criteria between waste management system configurations based on DOE's proposed I-MRS concept that uses a MRS facility as an integral part of the system and an alternative system configuration based on integration of dual purpose casks designed for at-reactor storage and spent fuel transportation without a MRS facility in the system referred to as the I-NO-MRS concept. DOE's NO-MRS concept is included in the comparison and evaluation for the first two criteria but not for the other criteria.

A. HEALTH AND SAFETY

The primary health and safety concerns are related to radiation exposure to current and future generations and consequences of non-radiological transportation accidents. A distinction is made in the acceptability of risk to the general public and risk to nuclear industry workers. This distinction is based on recognition that such workers understand the risk which they voluntarily accept and the general public is exposed to risk over which they have little knowledge or control. For comparison purposes concerns related to transportation and fuel handling are addressed separately recognizing that there is overlap in this approach.

Transportation

Table V.1 presents a classification of spent fuel for disposal in the first repository by at-reactor cask handling crane capacity and method of reactor transportation access for DOE's NO-MRS and I-MRS concepts and was used to develop the dual purpose cask I-NO-MRS concept (9). This is

TABLE V.1 - CLASSIFICATION OF SPENT NUCLEAR FUEL BY AT-REACTOR CASK HANDLING CAPACITY AND TRANSPORT ACCESS MODE

PERCENT OF FUEL FOR FIRST REPOSITORY

DOE's ASUMPTIONS	ALL RAIL MAX. CASK / CASK(TONS	150	125	100	40	25	TOTAL %
RAIL(100 TON)	UNRESTRICTED	14.3	40.0	14.3	0.9	0.1	69.6
TRUCK(25 TON)	BARGE	2.1	11.4		1.0		14.5
"	HEAVYHAUL (HH)	0.6	5.4				6.0
"	UPGRADE		0.8				0.8
"	UPGRADE & HH	0.7	2.4				3.1
"	TRANSFER		1.5	0.9			2.4
"	TRANSFER & HH	0.5	0.5	1.0	0.6		2.6
"	TRANSFER & HAUL		0.9	0.1			1.0
	TOTAL %	18.2	62.9	16.3	2.6	0.1	100.0

based on information provided to DOE by utilities and compiled by DOE's Pacific Northwest Laboratory. This data was used in a systems approach to optimize the integration of dual purpose cask into the transportation system in designing the I-NO-MRS concept to be responsive to public concerns about transportation of spent nuclear fuel (17).

The following transportation analysis is based on a parametric systems study (13) conducted at TVA in 1986 to examine the potential for optimization of various transportation system concepts to minimize transportation impacts. Transportation impacts are quantified in terms of four proxy measures based on the cask size appropriate to the concept and modified great circle distances from the reactors to the fuel destination. The proxy measures used are cask shipped, trip-miles, ton-miles, and cask-days which are defined below together with a discussion of their transportation impact implications. At this stage of comparison and evaluation of alternative system configurations this approach provides the system designer a faster and better understanding of interactions of components than can be achieved by performing detailed impact calculations which tend to obscure the basics due to the large number of often questionable assumptions that must be made.

Results of the parametric analysis for the three concepts are

TABLE V.2 - PARAMETRIC COMPAIRISON OF TRANSPORTATION SYSTEM IMPACTS MEASURES FOR SPENT FUEL MANAGEMENT SYSTEM ALTERNATIVES

NO AT-REACTOR ROD CONSOLIDATION:

	AUTHORIZED SYSTEM (DOE'S NO-MRS)	IMPROVED SYSTEM (DOE'S I-MRS)	INTEGRATED CASK SYSTEM (I-NO-MRS)
CASK SHIPPED(THOUSANDS)	30.1	33.5	9.5
TRIP-MILES(MILLIONS)	61.4	25.7	3.2
TON-MILES(BILLIONS)	5.02	3.86	3.24
CASK-DAYS(THOUSANDS)	136.9	65.8	32.5
PERCENT REDUCTION:			
CASK SHIPPED	BASE	-11.3	68.4
TRIP-MILES	BASE	58.1	94.8
TON-MILES	BASE	23.1	35.5
CASK-DAYS	BASE	51.9	76.3

FULL AT-REACTOR ROD CONSOLIDATION:

	AUTHORIZED SYSTEM (DOE'S NO-MRS)	IMPROVED SYSTEM (DOE'S I-MRS)	INTEGRATED CASK SYSTEM (I-NO-MRS)
CASK SHIPPED(THOUSANDS)	15.1	18.5	4.8
TRIP-MILES(MILLIONS)	30.8	13.5	1.6
TON-MILES(BILLIONS)	2.61	2.91	1.69
CASK-DAYS(THOUSANDS)	69.1	38.9	16.3
PERCENT REDUCTION:			
CASK SHIPPED	49.8	38.5	84.1
TRIP-MILES	49.8	78.0	97.4
TON-MILES	48.0	42.0	66.3
CASK-DAYS	49.5	71.6	88.1

shown in Table V.2 assuming that no rod consolidation takes place at the reactor sites and assuming that all the fuel will be consolidated at the reactor sites. The percent reduction in impact measures are also compared using DOE's NO-MRS concept as the base. To facilitate comparison of transportation system attributes Figure V.1 presents the same results displayed graphically. Table V.3 presents the percent improvement for each of the transportation system proxy measures that is achieved by the I-NO-MRS system configuration compared to DOE's I-MRS system configuration. Consolidating fuel at the reactor site reduces transportation impacts by about 50 percent for the cases with no MRS facility since each cask is capable of carrying twice as much fuel. The reductions are less for the case with a MRS facility. Some amount of fuel will be consolidated at the reactors, but it is impossible to make an accurate prediction of the quantity which will depend on DOE cooperation and incentives that might be offered if it is determine that overall system benefits justify such encouragement. Since the results are roughly proportional, comparison of impacts in the following discussion will be in terms of the no at-reactor rod consolidation scenario.

<u>TRIP-MILES</u> - This is the sum (one-way) of the individual trip-miles required to move the fuel from the reactors to the geologic repository (via MRS if applicable). A single cask shipped by truck or rail counts as one trip. Shipments that

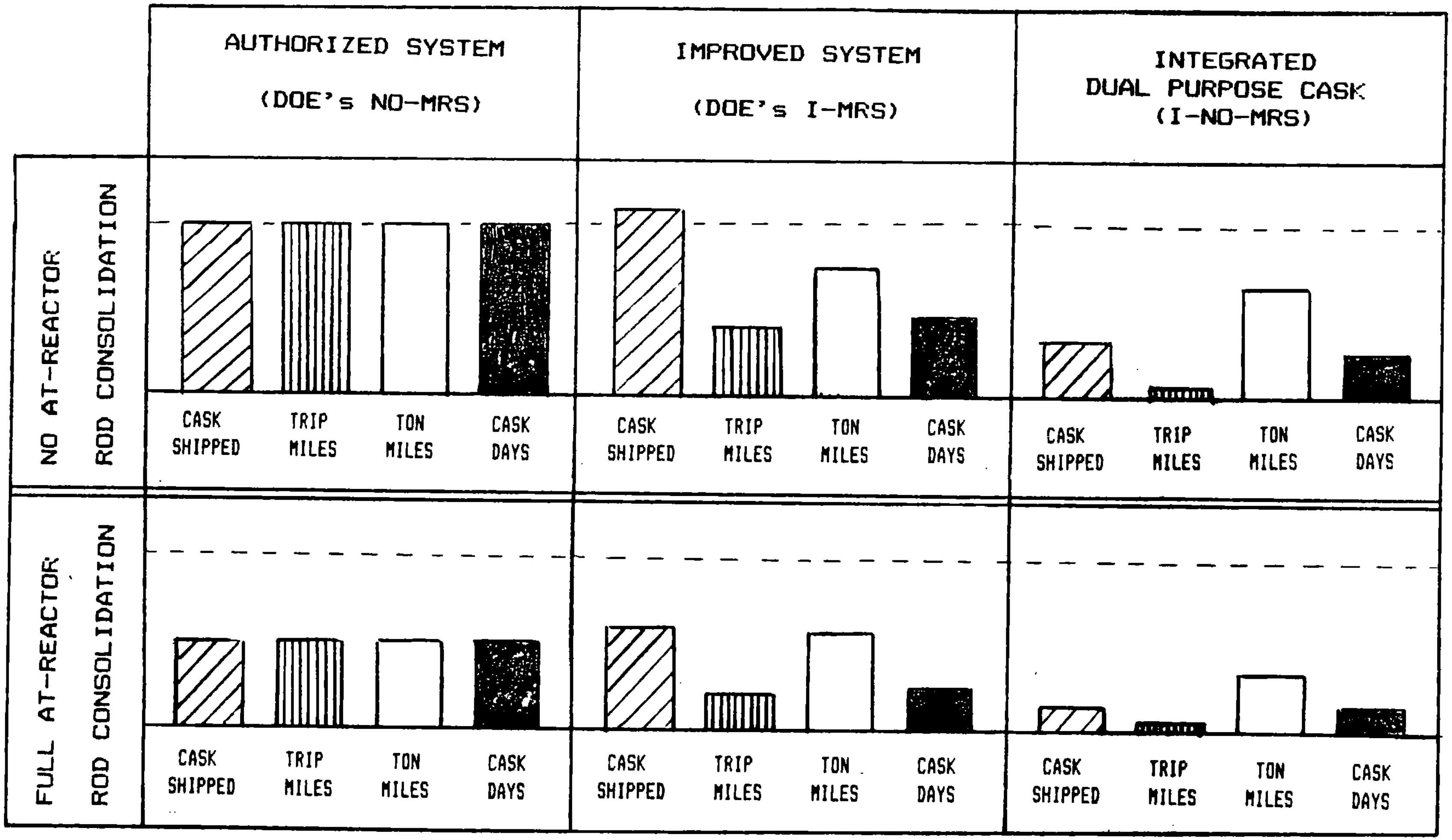


FIGURE V.1 - RELATIVE COMPARISON OF TRANSPORTATION SYSTEM IMPACT PROXY MEASURES FOR SPENT FUEL MANAGEMENT SYSTEM ALTERNATIVES

TABLE V.3 - REDUCTION IN TRANSPORTATION IMPACT MEASURES FOR THE DUAL PURPOSE CASK I-NO-MRS CONCEPT COMPAIRED TO DOE's INTEGRAL MRS SYSTEM CONFIGURATION CONCEPT

NO AT-REACTOR CONSOLIDATION:

CASK SHIPPED	72 % LESS
TRIP-MILES	88 % LESS
TON-MILES	16 % LESS
CASK-DAYS	50 % LESS

FULL AT-REACTOR CONSOLICATION:

CASK SHIPPED	74 % LESS
TRIP-MILES	88 % LESS
TON-MILES	42 % LESS
CASK-DAYS	58 % LESS

include several cask on the same train also count as one trip. The following transportation impacts are directly related to TRIP-MILES:

- o The potential for a shipment to be involved in an accident,
- o The cost of security, monitoring and emergency response, and
- o Public perceptions of shipping activity.

The obvious means by which TRIP-MILES can be reduced is through the use of larger capacity cask, minimizing truck shipment, making multiple cask shipments by rail, and shipping consolidated fuel.

The introduction of the I-MRS facility into the waste management reduces TRIP-MILES by about 62 percent compared to DOE's NO-MRS system configuration. This is due to multiple cask shipment of very large cask by dedicated train between the MRS facility in the east to the repository in the west. The average distance from the reactors to the MRS facility is about 800 miles and the distance from the MRS to the repository or the average distance from the reactors to the repository is about 2000 miles. However, when larger dual purpose cast in connection with multiple cask shipment by dedicated train is used to move fuel directly from the reactors to the repository in the I-NO-MRS system configuration TRIP-MILES are reduced by about 95 percent compared to DOE's NO-MRS concept and by about 88 percent compared to DOE's I-MRS concept.

<u>CASK-DAYS</u> - This is the total number of days cask loaded with fuel are in transit. Since transportation cask are designed to meet the same radiation protection standard (ten millirem per hour two meters from the surface of the conveyance vehicle), the nominal radiation exposure is essentially independent of how much fuel is in the cask. Therefore the radiological dose commitment to the public and transportation occupational workers is related to their proximity to the casks and the exposure time. Exposure time depends on the distance shipped and the speed of transit. The following typical average speeds for the indicated conveyance were used in this analysis:

Truck Shipment	35 MPH
Rail-Dedicated Train	25 MPH
Rail-General Commerce	7.5 MPH

Under these conditions CASK-DAYS is a proxy measure for radiological dose commitment to the public and transportation workers for the transportation system concepts being compared. The radiological dose commitments can be reduced by reducing the number of cask shipped and distance traveled, and by increasing the average speed of conveyance.

Including the I-MRS in the system reduces the CASK-DAYS by about 52 percent compared to DOE's NO-MRS concept. The I-NO-MRS concept reduces CASK-DAYS by 76 percent and 50 percent less than DOE's NO-MRS and I-NO-MRS concepts respectively.

CASK SHIPPED - This is the number of cask that must be loaded, shipped, and unloaded related to transportation. This does not include operations related to the use of storage-only casks for at-reactor storage or storage at a MRS facility. The following transportation impacts are directly related to the number of CASKS SHIPPED:

- Capital and operating cost of cask handling and transportation equipment, and
- Occupational radiological dose commitments related to handling, decontamination, and inspecting cask at the reactor and other facilities in the waste management system.

CASK SHIPPED can be minimized by using the largest capacity casts possible and reducing the number of times the fuel must be shipped.

The number of CASKS SHIPPED is increased by about 11 percent by placing the I-MRS facility in the system compared to DOE's NO-MRS system configuration. Use of the I-NO-MRS system configuration reduces the number of CASKS SHIPPED by 68 percent and 72 percent respectively compared to DOE's NO-MRS and I-MRS configurations.

TON-MILES - This is based on gross weight of round trip shipments including the fuel one way and is an indicator of freight charges related to transportation of spent fuel. The effectiveness of transportation casks in terns of payload per ton of gross weight decreases dramatical as cask size decreases. Therefore, to minimize TON-MILES, the largest cask practical should be used.

TON-MILES are reduced by about 23 percent when a I-MRS facility is included in the system compared to DOE's NO-MRS system configuration. Use of the I-NO-MRS system configuration reduces TON-MILES by about 65 percent and 16 percent compared to DOE's NO-MRS and I-MRS system configurations respectively.

Spent Fuel Handling

Figure V.2 compares simplified system configuration flow charts for DOE's I-MRS concept and the dual purpose cask I-NO-MRS concept to illustrate differences in fuel handling operations. Excluding transportation impacts discussed above, the impacts of spent fuel handling operations are almost entirely limited to nuclear industry occupational workers at the reactor sites, the MRS facility, and repository as appropriate. The health and safety impacts of these operations is dependent on the extent and location of fuel consolidation operations, the amount of at-reactor dry storage that will be required and the amount of fuel that will flow through dry storage at the MRS when included in the system. These are very uncertain at this time and no effort

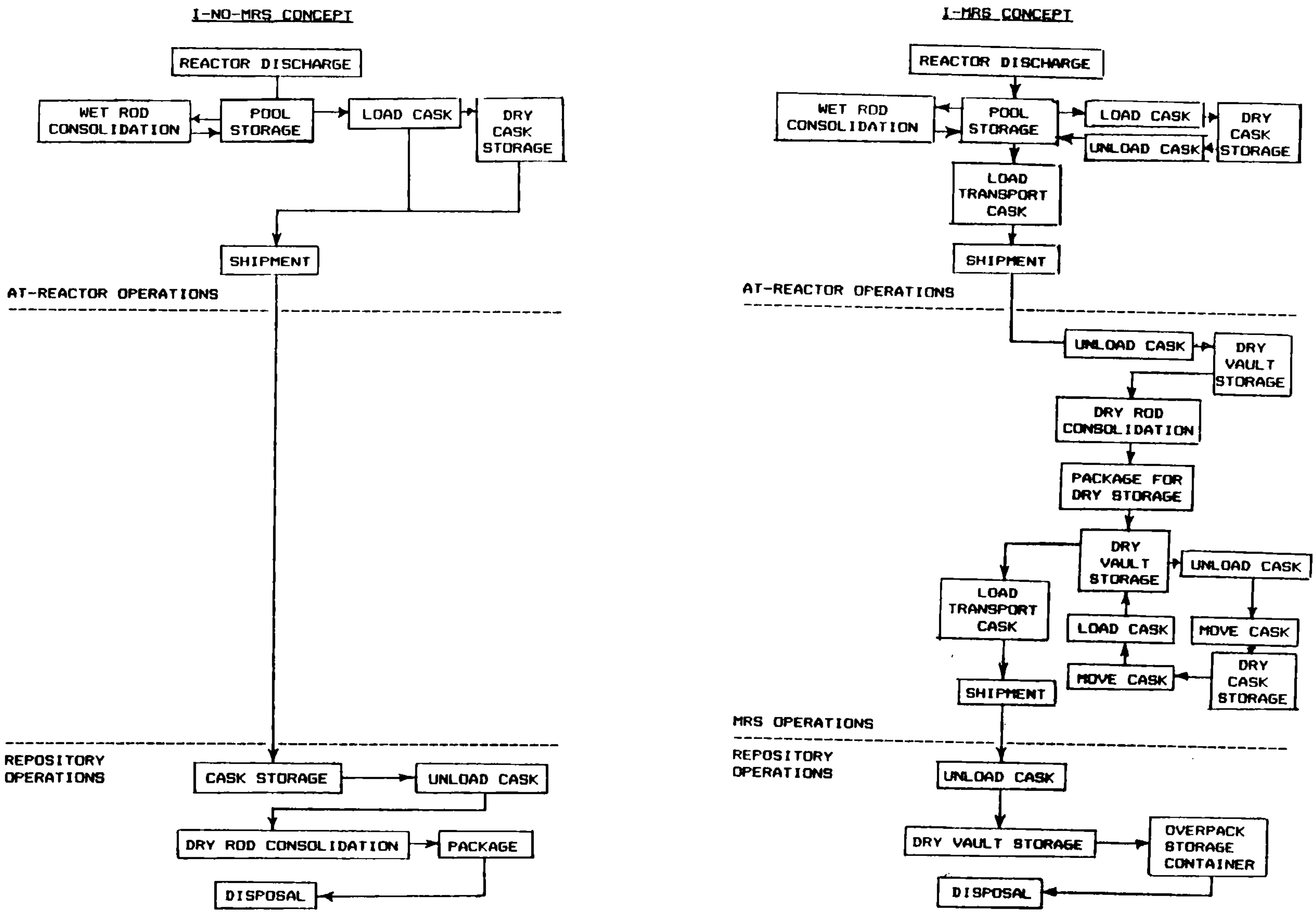


FIGURE V.2 - COMPARISON OF SPENT FUEL HANDLING OPERATIONS will be made to quantify these impacts in detail beyond the following general observations:

- o Including the I-MRS in the system requires shipping the fuel twice resulting in increased impacts,
- o The use of dual purpose cask for at-reactor storage in the I-NO-MRS concept eliminates the need to return storage-only cask to the reactor pool for unloading and reloading fuel into transport cask for shipment to the repository.
- o The larger average payload of dual purpose cask in the I-NO-MRS configuration results in reduced cask handling operations at the reactor site and at the repository.
- o The use of at-reactor rod consolidation reduces cask handling operations at the reactor sites and at the MRS or repository for any of the concepts.
- o Use of dry cask storage at the MRS as a staging device for classifying fuel for disposal results in unnecessary fuel handling operations compared to the use of dual purpose casks in the I-NO-MRS configuration.

<u>EVALUATION</u> - The use of the dual purpose cask I-NO-MRS system configuration concept results in reduction of health and safety related impacts by at least 50 percent compared to DOE's I-MRS system configuration. This is the result of optimization of the I-NO-MRS concept to be responsive to

public concerns by minimizing transportation impacts. DOE and utility industry representatives acknowledge that dual purpose cask can reduce radiological dose commitments but contends the reduction is not significant since the benefits are very small in real terms (14, 15). There is also a utility industry attitude that there is no need to improve on something that is adequate, that is, "the perfect is the enemy of the good" (16). From a purely technical standpoint they are correct in that the spent fuel can be transported safely using current practices to meet existing regulatory requirements. The position that there is no need to improve over these, however, is a value judgment that is not shared by all the stakeholders.

The NRC standard for radiation protection within prescribed limits is to keep dose commitments as low as reasonably achievable. Since major reductions in radiological dose commitments can be achieved without increased cost it would appear to be reasonable to adopt the integrated dual purpose cask concept for at-reactor storage and transportation with or without an MRS in the system. The adoption of such a system would, however, reduce the utility of the of I-MRS that DOE has proposed. NRC's regulation of spent fuel management activities is not systems oriented and has evolved over the past 30 years by responding to specific fuel cycle component needs as they arrive. There is some evidence that NRC has recently discovered the "tip of the iceberg" with regard to the potential for reducing radiological dose commitments through system integration. NRC was critical of the excessive fuel handling required for at-reactor storage using storage only cask in DOE's cask study required by the 1987 NWPA Amendments. NRC suggested that DOE should consider dual purpose cask or perhaps cask that can also be used as the disposal container. It is quite likely that NRC will, by it's own volition or in response to public pressure, start moving towards an integrate systems approach to regulating the overall spent fuel management system.

The general public, public interest organizations, local officials, and state agencies appear to very concerned about spent fuel transportation impacts and have the perception that spent fuel transportation is dangerous. The technical community, that support DOE and nuclear utility industry activities tend to discount these concerns since they do not feel the concern is justified. Whether these public concerns or perceptions are justified really makes little difference they are a reality that must be taken into account to be successful in implementing any waste management system configuration. Therefore it is important to be able to demonstrate that a creditable effort has been made to minimize transportation impacts. The I-NO-MRS concept which effectively integrates dual purpose cask into the transportation system represents a more convincing effort and would likely have better public acceptance than the I-MRS and transportation system configuration proposed by DOE.

B. ECONOMIC

The economic comparison of alternative system configurations should be based on waste management system life cycle cost including expenditures by utilities for at-reactor storage and the cost of mitigation or compensation to state and local governments for impacts related to spent fuel management activities. DOE is the only source of information on the life cycle cost of the waste management system exclusive of at-reactor storage. The latest available life cycle cost information published by DOE, at the time of this study was for DOE's June 1987 revision of their Nuclear Waste Fund Fee Adequacy Assessment (19, 20). This did not incorporate waste management program revisions included in the 1987 NWPA Amendments. A probabilistic waste management system economics computer model was developed for use in another study (21) to examine uncertainty in the adequacy of the nuclear waste fund fee and has been adapted for use in this study. The model is based on adjustment of the DOE's NO NEW ORDERS CASE WITH INCREASED BURNUP ASSUMING THE FIRST REPOSITORY IS IN TUFF AND THE SECOND REPOSITORY IS IN SALT WITH A MRS AS AN INTEGRAL PART OF THE SYSTEM. To reflect 1987 NWPA Amendments the following changes were made:

- The quantity of commercial spent fuel for disposal was reduces from 88 thousand tons to 74 thousand tons to better reflect expected spent fuel production,

- o The second repository was eliminated and it was assumed that all fuel would be placed in the first repository,
- o A new category of cost for COMPENSATION was added for payments to the repository and MRS facility host state,
- o Development and evaluation cost were disaggregated to show development and evaluation cost for each major component of the system and overall program administration cost as separate items, and
- o The base case was modified to began MRS and repository operation in 2003.

At-reactor storage cost is based on DOE estimates included in the initial version of the Dry Cask Storage Study (22) prepared in response to requirements in the 1987 NWPA Amendments. Table V.4 summarizes DOE's aggregate cost estimates for providing at-reactor storage for several scenarios based on EIA's NO NEW ORDERS CASE estimate of spent nuclear fuel production. DOE's estimate of the amount of supplemental at-reactor storage is also shown for each scenario. The range between the UPPER BOUND and LOWER BOUND 1 represents the unit-cost for storage technology that has been fully proved and demonstrated in the United States. This technology is the current design of metal storage cask--that is, a cask designed without taking credit for fuel burnup. Assuming that several hundred cask will be required, the purchase price should range from \$70 to \$90 per killogram of heavy metal. LOWER BOUND 2 represents the cost reductions expected from technology improvements that are believed to be likely. For metal storage cask, these likely improvements include increased capacity and less expensive baskets that would result from NRC allowing credit for fuel burnup; they also include the successful demonstration of concrete storage modules. This represents DOE's lowest cost estimates for dry storage cask and mid range cost for concrete storage modules. The LOWER BOUND 3 represents DOE's lowest estimates of providing storage by rod consolidation in conjunction with any additional dry storage based on the lowest estimated cost for concrete storage modules.

Table V.4 - Estimated Aggregate Cost of Providing At-Reactor Storage

Millions of Dollars

	REQD MTHU	WASTE ACCEPTANCE	UPPER BOUND	LOWER BOUND 1	LOWER BOUND 2	LOWER BOUND 3
NO MRS	12,220	2003	1,267	945	701	468
WITH MRS	4,530	1998	490	360	270	180
"	9,780	2003	1,020	760	560	370
"	17,230	2008	1,770	1,330	980	680

The LOWER BOUND 2 aggregate cost estimates for providing supplemental at-reactor storage is conservatively assumed for the nominal estimates in this study. This is believed to be conservative for the following reasons:

- o DOE has consistently overestimated spent fuel production which results in overestimating at-reactor supplemental storage requirements.
- o Utilities have consistently underestimated their ability to provide at-reactor pool storage in their reports to DOE which is the basis for DOE's estimates which results in overstating supplemental storage requirements. DOE acknowledges the uncertainty in these estimate by observing that "a comparison of the maximum pool capacities estimated by utilities shows a large variation among reactors in the loading of the storage pools--that is, the metric tons of heavy metal (MTHM) stored per unit of pool floor area". Small differences in estimates of cumulative fuel production and maximum storage capacity can produce dramatic changes in the estimated addition at-reactor storage requirements. As an example a 5 percent reduction in cumulative spent fuel production in conjunction with a 10 percent increase in maximum storage capacity results in about a 40 percent reduction in the supplemental at-reactor storage requirements by 2003 for DOE's NO-MRS scenario.
- o DOE's aggregate cost estimates tend to be based on somewhat conservative assumptions on unit-cost and technology utilization.

- o DOE does not consider at-reactor storage of consolidated fuel in metal cask or concrete storage modules which are very attractive options for reducing the effective cost of these technologies.

Figure V.5 gives results for the start of repository and MRS facility operation in 2003 consistent with DOE's current repository schedule and the linkages Congress placed on the MRS authorized in the 1987 NWPA Amendments. Nominal total waste management system life cycle cost including at-reactor storage is presented in 1986 dollars for each major component of system cost. On this basis, DOE's I-MRS system configuration would cost about 1.9 and 3.1 billion dollars more than DOE's NO-MRS and the dual purpose cask I-NO-MRS system configurations respectively.

Most of the stakeholders that are familiar with the repository program think it almost certain that DOE will not have the repository in operation in 2003 as scheduled, but are not very specific on the extent of the delay (18). The effects of delaying the operation of the repository and MRS facility five years to 2008 are shown in Table V.6 for the three system configurations. While their is a general increase in the overall program cost under this scenario the cost for DOE's I-MRS concept increases to about 2.2 and 3.4 billion dollars compared to DOE's NO-MRS and the I-NO-MRS concepts. Table V.7 indicates the effects of removing the

TABLE V.5 - TOTAL WASTE MANAGEMENT SYSTEM LIFE CYCLE COST

REPOSITORY (& MRS) OPERATION STARTING IN 2003

COST IN MILLIONS OF 1986 DOLLARS

	AUTHORIZED SYSTEM (DOE'S NO-MRS)	IMPROVED SYSTEM (DOE'S I-MRS)	INTEGRATED CASK SYSTEM (I-NO-MRS)
TRANSPORTATION:			
DEVELOPMENT	1,080	1,080	882
FAC. & OP.	1,928	1,623	1,370
SUB TOTAL	3,008	2,703	2,252
MRS FACILITY:			
DEVELOPMENT		125	
FAC. & OP.		2,699	
SUB TOTAL	0	2,824	0
REPOSITORY:			
DEVELOPMENT	5,631	5,631	5,631
FAC. & OP.	7,000	6,000	6,700
SUB TOTAL	12,631	11,631	12,331
COMPENSATION:			
REPOSITORY	1,450	1,450	1,450
MRS		365	
SUB TOTAL	1,450	1,815	1,450
ADMINISTRATION	1,823	2,023	1,710
DOE TOTAL	18,912	20,996	17,743
AT-REACTOR STORAGE	701	560	701
SYSTEM TOTAL	19,613	21,556	18,444
SAVINGS	(1,943)	BASE	(3,112)

TABLE V.6 - TOTAL WASTE MANAGEMENT SYSTEM LIFE CYCLE COST

REPOSITORY (& MRS) OPERATION STARTING IN 2008

COST IN MILLIONS OF 1986 DOLLARS

	AUTHORIZED SYSTEM (DOE'S NO-MRS)	IMPROVED SYSTEM (DOE'S I-MRS)	INTEGRATED CASK SYSTEM (I-NO-MRS)
TRANSPORTATION:			
DEVELOPMENT	1,400	1,400	1,132
FAC. & OP.	1,928	1,623	1,370
	--------	--------	--------
SUB TOTAL	3,328	3,023	2,502
MRS FACILITY:			
DEVELOPMENT		180	
FAC. & OP.		2,849	
	--------	--------	--------
SUB TOTAL	0	3,029	0
REPOSITORY:			
DEVELOPMENT	8,131	8,131	8,131
FAC. & OP.	7,000	6,000	6,700
	--------	--------	--------
SUB TOTAL	15,131	14,131	14,831
COMPENSATION:			
REPOSITORY	1,450	1,450	1,450
MRS		390	
	========	========	========
SUB TOTAL	1,450	1,840	1,450
ADMINISTRATION	2,123	2,323	2,010
	========	========	========
DOE TOTAL	22,032	24,346	20,793
AT-REACTOR STORAGE	1,121	980	1,121
	========	========	========
SYSTEM TOTAL	23,153	25,326	21,914
SAVINGS	(2,173)	BASE	(3,412)

TABLE V.7 - TOTAL WASTE MANAGEMENT SYSTEM LIFE CYCLE COST

MRS STARTING IN 1998 & REPOSITORY IN 2008

COST IN MILLIONS OF 1986 DOLLARS

	IMPROVED SYSTEM (DOE'S I-MRS)
TRANSPORTATION:	
DEVELOPMENT	1,200
FAC. & OP.	1,623
SUB TOTAL	2,823
MRS FACILITY:	
DEVELOPMENT	125
FAC. & OP.	2,669
SUB TOTAL	2,794
REPOSITORY:	
DEVELOPMENT	8,131
FAC. & OP.	6,000
SUB TOTAL	14,131
COMPENSATION:	
REPOSITORY	1,450
MRS	365
SUB TOTAL	1,815
ADMINISTRATION	2,273
DOE TOTAL	23,836
AT-REACTOR STORAGE	270
SYSTEM TOTAL	24,106

linkage between operation of the MRS facility and progress on the repository by assuming that the MRS facility starts operation 1998. This would save about 1.2 billion dollars for the I-MRS system configuration and reduces the economic advantage of the NO-MRS and I-NO-MRS configurations to about 1.0 and 2.2 billion dollars respectively.

The preceding discussion has been in terms of nominal cost estimates based largely on very preliminary conceptual designs for facilities that have never been designed, licensed or operated. Past experience with such nuclear related facilities indicate that major cost increases are not uncommon and are expected as the design, licensing, and construction of the system progresses. DOE has acknowledged a high degree of uncertainty in the cost of providing at-reactor storage (22) and executives from some well informed nuclear electric utilities indicate there is some uncertainty in at-reactor storage cost, but not as much uncertainty as there is associated with the MRS (16, 23). The following analysis takes into account the effects of these uncertainties in the economic evaluation of the alternatives.

The methodology used structures the problem to be analyzed as an event tree that covers a wide range of possible outcomes by representing the decisions to be made and uncertainties branching points. Probability is the language used to describe uncertainties so the effects can be incorporated into the analysis to produce probabilistic risk profiles of the life cycle cost for the alternative system configurations. The development of the input probability distributions used is a subjective process and represents the opinion of the author. While these reflect the experience and knowledge of the author it is the type of data about which well informed experts might disagree. Uncertainty in:

- o at-reactor storage cost.
- o MRS facility and operating cost, and
- o cost of compensation

are considered in the analysis. It would be possible to treat the repository operating date as an uncertainty which is assumed to be 2008 for the purposes of this analysis. The probability distributions used are described below.

<u>At-Reactor Storage Cost</u> - The aggregate DOE cost estimates for providing at-reactor storage from Table V.4 is the basis for developing the cumulative probability distributions shown in Figure V.3 for operation of the I-MRS in 1998 and 2008 and for the NO-MRS and I-NO-MRS concepts.

<u>Compensation Cost</u> - The initial version of compensation legislation passed in the Senate provided for compensation five times greater than that approved in conference with the House. The compensation provided in

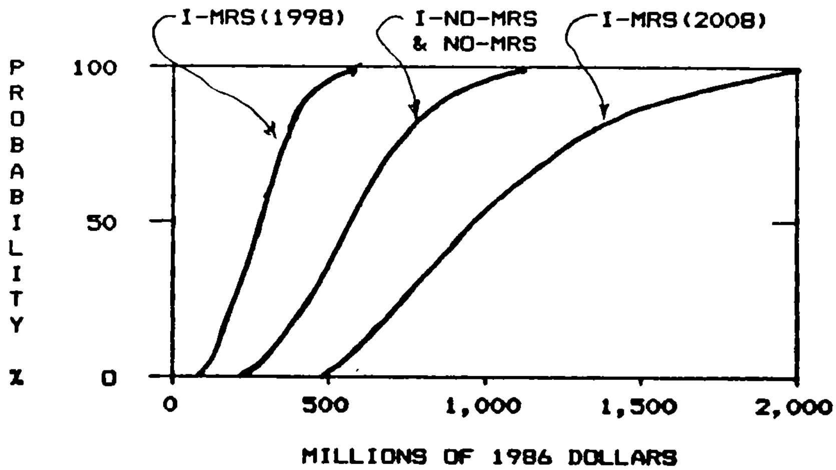


FIGURE V.3 - AT-REACTOR AGGREGATE COST UNCERTAINTY

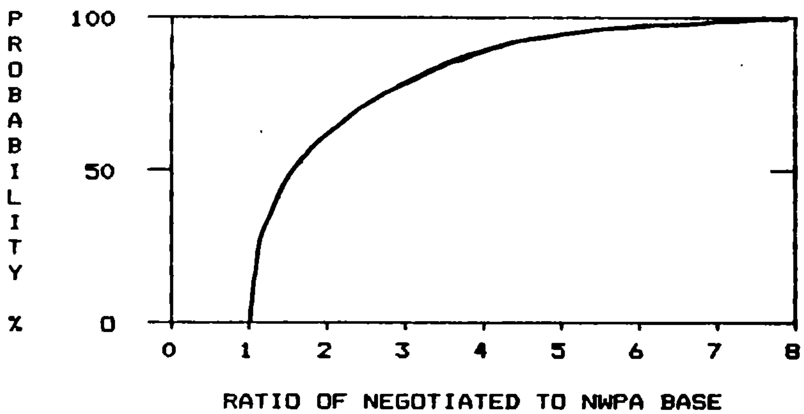


FIGURE V.4 - UNCERTAINTY IN STATE COMPENSATION COST

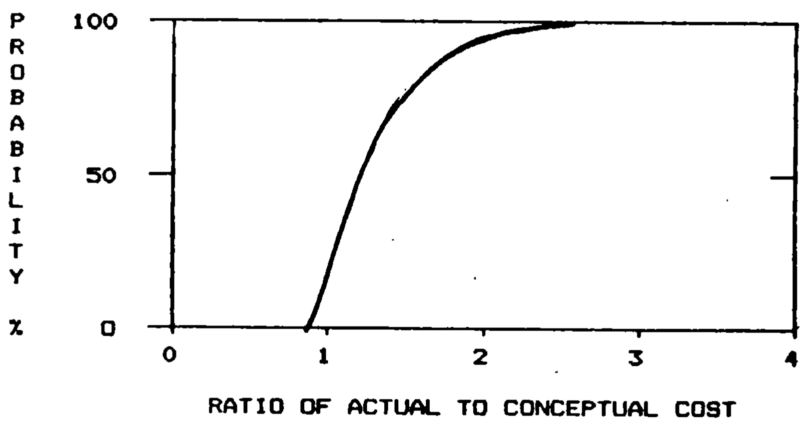


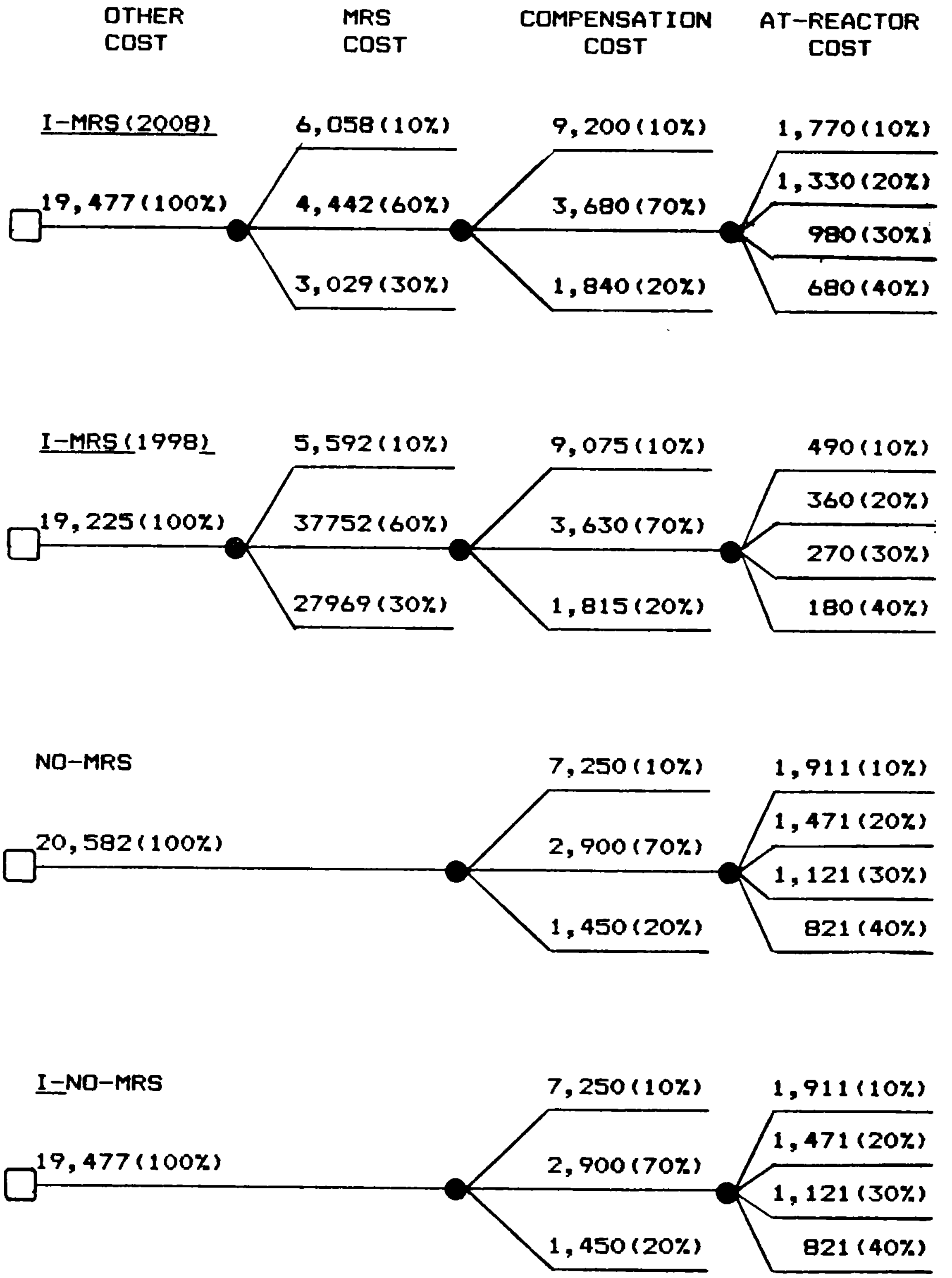
FIGURE V.5 - UNCERTAINTY IN MRS COST

the 1987 NWPA Amendments can be viewed as the floor and the Senate version as the ceiling between which compensation can be negotiated, Compensation for the MRS is only half of that provided for the repository host state yet tangible impacts related to a MRS facility are much larger than for a geologic repository over the next 50 to 100 years. Politicians tend to have relatively high discount factors when negotiating on behalf of their constituents. The cumulative probability distribution used to describe uncertainty in negotiated compensation cost is shown in Figure V.4 relative to the NWPA base rates.

MRS Cost - The proposed MRS involves the use of: a complex automated dry rod consolidation process, robotics for cask and fuel handling operations, and use of large portable concrete storage cask. While these technologies are feasible, they are yet to be developed, demonstrated, and licensed and as such represent significant uncertainty in cost. Figure V.5 shows the cumulative probability distribution used to describe this uncertainty in MRS cost (21).

A shorthand representation of the event trees and related discreet probabilities used to represent the above distributions for the four system configurations analyzed is shown in Figure V.7 based on a 2008 expected repository

FIGURE V.7 - EVENT TREES FOR ANALYSIS OF COST UNCERTAINTY



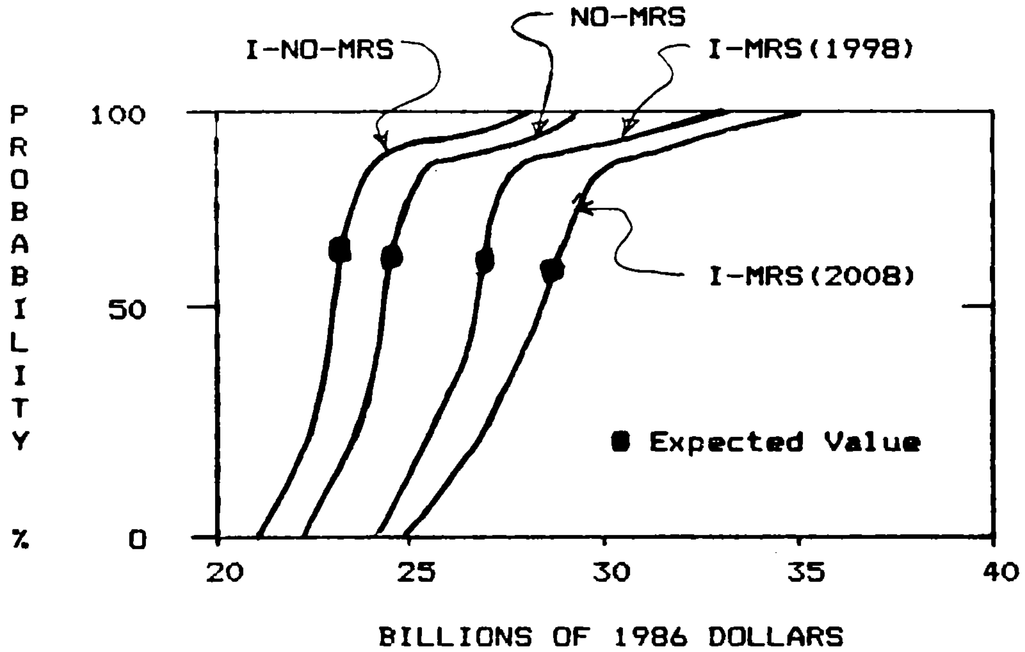


FIGURE V.8 - TOTAL LIFE CYCLE COST UNCERTAINTY FOR REPOSITORY OPERATION IN 2008

TABLE V.8 - COMPAIRISON OF NOMINAL AND EXPECTED TOTAL SYSTEM LIFE CYCLE COST FOR 2008 REPOSITORY OPERATION

MILLIONS OF 1986 DOLLARS

	NOMINAL COST		EXPECTED VALUE	
	AMOUNT	INCREASE	AMOUNT	INCREASE
DOE'S NO-MRS	23,150	1,236	24,777	1,239
DOE'S I-MRS(2008)	25,326	3,412	28,530	4,992
DOE'S I-MRS(1998)	24,106	2,192	26,974	3,436
I-NO-MRS	21,914	BASE	23,538	BASE

operating date. Resulting probabilistic risk profiles are shown in Figure V.8 in terms of total system life cycle cost in billions of 1986 dollars. The mean or expected value is shown for each of the distributions and is the best overall indicator of the relative economic merit of the system configurations considered. The nominal cost and expected value cost are compared in Table V.8 in terms of increase in cost relative to the I-NO-MRS system configuration. When uncertain in cost is considered the disadvantage of DOE's I-MRS concept increased from about 3.4 to 5.0 billion dollars if MRS operation is also delayed until 2008. If the linkage of MRS operation to repository progress were removed and the MRS began operation in 1998 the disadvantage of DOE's I-MRS concept increases from about 2.2 to 3.4 billion dollars. The savings in at-reactor storage cost resulting from earlier MRS facility operation remains about constant at 1.6 billion dollars.

I-NO-MRS system configuration concept based on effective integration of dual purpose cask into the overall system has a decisive economic advantage over DOE's proposed I-MRS system configuration with a MRS facility as an integral part of the system. The I-NO-MRS also has a significant economic advantage over the NO-MRS concept that DOE used as the basis for comparison to their I-MRS concept.

C. ENVIRONMENTAL

Aside from health and safety considerations addressed above there does not appear to be any significant near-term environmental differences between DOE's NO-MRS, and I-MRS concepts or the dual purpose cask I-NO-MRS concept described in this study over the useful service life of the nuclear plants. Monitored retrievable wet and dry storage is and will be practiced at reactor sites whether or not there is a MRS in the system, there is only a difference in degree and not the type of activities. A central MRS facility will require dedication of about 500 to 800 acres of land to this application. Nearly all nuclear plants should, if necessary, be able to accommodate life of plant storage on the existing plant sites currently dedicated to nuclear use. Even with a MRS in the system, storage at an MRS would be less than 20 percent of the spent fuel in the system unless there is an extended delay in or abandonment of getting a geologic repository in operation. The principal environmental concern is related to getting a MRS facility in the system then reneging on the commitment to a geologic repository.

The question has been poised, Is it better to have one central MRS facility as a defacto repository or to have a hundred defacto repositories at the reactor sites? (24). While, in the past, there has been advocates of monitored retrievable storage as an alternative to geologic disposal, there has been no overt support for this approach. None of the stakeholders appearing before the MRS Review Commission have suggested that the MRS be considered as an alternative to a geologic repository and all continue to publicly support emphasis on a geologic repository. There is some evidence that suggest that, monitored retrievable storage in a geologic repository might be more practical than permanent disposal in a geologic repository. This form of MRS, however is not related to the I-MRS concept proposed by DOE and is not at issue in this analyses.

If the delay in repository operation is beyond the year 2020, there will probably be increasing pressure to decommission nuclear power plant sites where the reactors are no longer in service. In this event, the dual purpose cask used in the I-NO-MRS concept, can continue in service at the reactor site after the reactor has been decommissioned since it is not necessary to return fuel to the reactor pool for loading into a transport cask. Should it be desirable to remove dual purpose cask from the reactor site, they can be shipped to a temporary storage (MRS) site and then be shipped to the repository when it is available without removing fuel from the cask. While this is more than a remote possibility, the decision to implement this form of centralized storage can be deferred for to well beyond the turn of the century, when we should have better information, without compromise in the I-NO-MRS concept. Virtually all the stakeholders that has appeared in the MRS Review Commission Hearings believe the decision to include a MRS as an integral part of the system as proposed by DOE could undermine the commitment to a geologic repository, except for those that would benefit financially (investor owned utility stockholders and local benefactors of related jobs and government compensation).

Evaluation - Over the next 30 years or so there is no major environmental differences, excluding health and safety, that serve as significant discriminator between the alternative system configurations considered if the repository schedule were not effected. However, long term environmental considerations clearly favor the I-NO-MRS concept over DOE's I-MRS concept due to related political, fairness, and scheduling implications which are addressed further under these specific criteria.

D. POLITICAL

Political considerations are addressed in terns of POLITICAL ACCEPTABILITY, PUBLIC CONFIDENCE, and LOCAL AND STATE ATTITUDES.

POLITICAL ACCEPTABILITY

A working consensus among the stakeholders is essential to successfully implement any of the waste management system configuration alternatives considered. This consensus must be robust enough to endure for several decades to minimize the risk of having the consensus unravel or be undermined by opponents of the alternative selected. Based on the testimony of congressional staffers (25) before the Commission and communications to the Commission by individual Congressmen it appears that there probably is not enough Congressional support for DOE's proposed I-MRS concept to sustain a bare majority when considered on its merits. This is also evident by the circumstances in which the MRS was authorized and the constraints placed on MRS use in the 1987 NWPA Amendments as well as the existence of the MRS Review Commission to consider the need for such a facility. Open debate of the issue was finessed by last minute inclusion in a continuing budget resolution to avoid shutdown of the federal government. The preponderance of the stakeholder testimony before the Commission appears to find expanded at-reactor storage more acceptable than DOE's proposed I-MRS concept. This decisively favors the I-NO-MRS concept over DOE's proposed I-MRS concept. Congress will, almost surely, revisit this issue after the Commission makes its recommendations.

PUBLIC CONFIDENCE - There are two separate public confidence issues related to the MRS. The first is a question of trust and confidence in DOE. The other is that Congress may not have the political will to deny use of MRS facility as a defacto repository if there is an extended delay in operation of the geologic repository.

Credibility and public trust is, perhaps, the most valuable asset that any institution can have when undertaking to deal with a controversial public policy issue like nuclear waste management. DOE has very little of either due to the manner in which the government has managed defense related nuclear facilities over the past 30 to 40 years. The full extent of this mismanagement is only now beginning to come to light. DOE's implementation of the NWPA through it's Office of Civilian Radioactive Waste Management (OCRWM) has done little to cause anyone to believe that DOE is capable of conducting the publics business in a open and honest way that is responsive to stakeholder concerns. The NWPA places DOE's civilian waste program under NRC regulatory jurisdiction which should, in theory, result in some improvement in DOE accountability. However, the effectiveness of one federal agency regulating another federal agency is yet to be demonstrated. Thus far NRC has been reluctant to take a leadership role in overseing integration of components of the overall waste management system. Testimony before the MRS Review Commission strongly suggest that the general public, public interest groups and representative of state and local government place more credibility and trust in public utilities than in DOE. This situation clearly favors the I-NO-MRS concept over DOE' I-MRS concept since it minimizes dependance on DOE. DOE's credibility problem transcends the MRS issue and will probably require the establishment of a new institution outside DOE along the lines of the AMFM panel recommendations.

Most of the stakeholders are concerned that the availability of a MRS facility in the waste management system will result in the facility becoming a defacto repository. In response to this concern DOE proposed linking use of the MRS to progress on the repository and Congress strengthened the linkages when the MRS was authorized. All of the stakeholders, except investor owned utilities who would like to see the linages relaxed, believe the linkages are sacrosanct. Even with the linkages they are fearful that if the repository program gets into extended delays and a MRS facility is available Congress will under budget and other pressures remove the restrictions allowing the MRS to become a defacto repository. The only safe way to prevent his to not build a MRS facility. This concern decisively favors the I-NO-MRS concept over DOE's proposed I-MRS concept since it removes the basis for future temptation.

<u>LOCAL AND STATE ATTITUDE</u> - Local and state governments seem to share distrust of DOE and concern about the risk of a MRS becoming a defacto repository. There does, however, appear to be some significant differences in attitude about being host to a MRS facility. At the local level a MRS is viewed by some as an asset with regard to jobs, compensation, and economic development in the immediate area (30). Locals feel that the broader question of the need for such a facility or

its broader implications is beyond their purview. State governments, however, tend to take a broader view with regard to the need for such a facility, the effects on taxpayers and ratepayers, and broader economic development issues as well as concerns of their constituents across the state (26). States also seem to have the attitude that waste tends to stay where it is put and their experience suggest that waste generators are more responsive when they must deal with the problem at the source (26, 27). Therefore, it seems unlikely that local enthusiasm for a MRS would overcome the stronger state position recognizing that the State has veto power. Moreover, it would probably be political suicide for an elected state official to actively support hosting a MRS facility if there is widespread opposition among their constituents. This situation decisively favors the I-NO-MRS concept over DOE's I-MRS concept since it avoids the issue.

E. SOCIAL

The principal differences in the concepts considered with regard to social criteria is public fears and anxieties related primarily to transportation of spent fuel. Many in the technical community believe this is an irrational fear that can be mitigated through education of the public. This is, perhaps, true to some extent. However, the technical community is in need of education with regard to the reality of being responsive to public concerns. The public generally recognizes that nuclear power plant sites are not suitable for permanent disposal of spent nuclear fuel and at some point in the future it will be necessary to move the spent fuel to a suitable repository site for disposal. They seem to have a definite preference to leave the fuel where it is until we know for sure how, when and to where the fuel will be moved for disposal. Even in moving the fuel once it is important to be able to convince the public that everything that can be reasonably done to reduce the risk and impacts on the public has been done. The same improvements in the transportation system, discussed above, related to health and safety are also applicable to reducing public fears and anxieties related to transportation. The I-NO-MRS is clearly superior to DOE's I-MRS concept for this criteria.

F. FAIRNESS

Fairness issues related to the MRS can be divided into those relating to LIABILITY and those related to EQUITY.

LIABILITY

The Findings and Purposes of the NWPA clearly places the responsibility on the Federal Government to provide for the permanent disposal of high-level waste and spent nuclear fuel and that the owners and generators should be responsibility for the cost of such disposal and have the primary responsibility provide for , and to pay the cost of, the interim storage of such waste and spent fuel until such waste and spent fuel is accepted by the DOE Secretary in accordance with the provisions of the NWPA. In the development of the NWPA the nuclear utility industry succeeded in getting a commitment to a specific date to start disposal in return for agreeing to pay a fee on nuclear generation to finance the program. Section 302 of the NWPA provides for the Secretary to enter into contracts with the owners and generators. Paragraph a5 specifically provides:

> Contracts entered into under this section shall provide that--
>
> (A) following commencement of operation of a repository, the Secretary shall take title to the high-level radioactive waste or spent nuclear fuel involved as expeditiously as practical upon the request of the generator or owner of such waste or spent fuel; and
>
> (B) in return for payment of fees established by this section, the Secretary, beginning not later than January 31, 1998, will dispose of high-level radioactive waste or spent nuclear fuel involved as provided in this subtitle.

In 1984 Senator Jhonson requested a legal opinion from DOE regarding DOE's obligation and authority to take title to spent nuclear fuel in the event a repository has not yet commenced operation by January 31, 1998. The initial response from DOE's General Council was not satisfactory to Senator Jhonson. Secretary Hodel then responded giving assurance that DOE is obligated and has authority to accept high-level radioactive waste and spent nuclear fuel on an orderly schedule not later than January 31, 1998 and pursuant to his authority would include such provision in the contracts. This was done, but the contract provides no remedy if DOE fails to perform.

The investor owned utilities interpret this contractual provision as an unequivocal commitment to start taking their fuel in 1998 and with the delay in the repository the MRS facility is the vehicle through which DOE can fulfill the obligation. There is some indication that utilities will sue DOE for damages (15). It should, however, be clear from the language in the NWPA that the owners and generators have the full liability for the fuel until DOE accepts it for disposal and they continue to have the financial liability related to disposal after DOE accepts the fuel. Simple reading of the NWPA indicates that DOE can only accept title to the fuel when a repository is in operation as indicated by the underlined passages above which would suggest that DOE exceeded their authority under the NWPA. There is, perhaps, enough ambiguity on this point for argument among lawyers. It now appears unlikely that DOE could accept spent fuel by 1998 even if an MRS is built due to linkages to the repository. It might well be a moot question in any event. If a utility were successful in getting a financial judgment against DOE the only source of funds available to DOE would be the Nuclear Waste Fund which must be supported by the owners and generators of the waste. There does not appear to be any ambiguity in the NWPA on this point. In this event other utilities would be forced to subsidize the utility getting the judgment which raises an equity question. Under the circumstances DOE's contractual obligation to take a utilities fuel is a dubious basis for justification of an MRS facility that is expected to cost the utilities ratepayers about 5 billion dollars more than having the utilities take care of their own fuel, another equity question. It would appear that investor owned utility supporters of the MRS are not driven by stewardship of their ratepayers interest.

The liability issue can only be addressed definitively by the Courts or Congress. However, the related equity issues favors the I-NO-MRS concept over DOE's I-MRS concept.

Equity

In addition to the equity issues mentioned above in connection with contract liability question there are:

- o GEOGRAPHIC,
- o INTERGENERATIONAL,
- o INTERUTILITY,
- o UTILITY-RATEPAYER, and
- o GOVERNMENT-UTILITY

equity issues involved in the having a I-MRS in the waste management system.

GEOGRAPHIC - While not explicitly included in the NWPA there was an understanding that the first repository would be in the west and the second repository in the east to provide a geographic balance of responsibility for high-level waste disposal. With suspension of the second repository it has been suggested that placing the I-MRS in the east would restore geographic balance to the program (9). Upon examination this is a specious argument in that it would increase public exposure to anxieties and risk for no useful purpose. It would be analogous to deliberately exposing more people to AIDS so those that have AIDS might be less sensitive because they have more company. From a geographic perspective it would be most equitable to leave the fuel at the reactor sites until it can be shipped directly to the repository with minimum public exposure. This also keeps, to the extent practical, the nuclear waste and related risk in proximity to those that benefited from its production. From a geographic equity perspective the I-NO-MRS concept is clearly better than DOE's proposed I-MRS concept.

INTERGENERATIONAL - Public interest groups believe that this generation has the obligation to deal with the nuclear waste it produces rather than deferring the problem to future generation that did not benefit from its production. They reason that the presence of a MRS facility in the system will undermine the commitment to proceed with a geologic repository. A waste management system configuration based in the I-NO-MRS concept is clearly superior to DOE's I-MRS concept since it removes the temptation.

INTERUTILITY - Some utilities are going ahead in a responsible manner to provide for any at-reactor storage they might need to assure that they are in a position to not jeopardize continuing plant operation. It would be unfair to require them to also pay for a MRS they don't need as well as subsidize those utilities that are unwilling to take care of their own waste. This criteria clearly favors the I-NO-MRS concept over DOE's I-MRS concept.

UTILITY-RATEPAYER - The inclusion of DOE's proposed I-MRS as am integral part of the waste management system results in an unnecessary expenditure of an additional five billion dollars (expected value) that will be paid for by utility ratepayers. While DOE's acceptance of title to the waste for storage at a MRS would reduce the utility and its stockholders liability to provide storage it results in disproportionate and unfair increase in the ratepayers financial liability. Since the I-MRS as proposed by DOE is an integral part of the system and paid for out of the Nuclear Waste Fund it is unlikely that a Public Utility Commission (PUC) could require the stockholders to accept any liability associated with the excessive and unnecessary cost related to the I-MRS. On the other hand a PUC retains some control over allocation of cost for at-reactor storage and can protect the ratepayers interest by examining the prudence of the utilities expenditures for providing for spent fuel storage. The I-NO-MRS concept is decisively superior to DOE's I-MRS concept in this respect.

<u>GOVERNMENT-UTILITY</u> - The government has had the sole responsibility for high-level nuclear waste disposal from the very beginning of the commercialization of nuclear power. This was an essential part of the Government decision and program to promote the peaceful uses of nuclear power as a nuclear weapons nonproliferation strategy. The government clearly as failed to carry out it's responsibilities over the past 30 to 40 years to the point of helping to jeopardize the future viability of nuclear power. While there may not be a great deal of sympathy for the utilities among the general public, public interest groups and state governments the utilities have been unfairly given the full responsibility for providing for interim storage until such time as the government accepts the waste for disposal. From a fairness standpoint the utilities should be entitled to some assistance. The I-MRS concept would provide some relief by sharing the interim storage responsibility but in a very ineffective, expensive, and counter productive manner. If the Congress should decide to provide some relief to utilities by sharing interim storage responsibility between the government and utilities it can be done very effectively and economical with the I-NO-MRS system configuration. It, however, is very important to do this in a way that utilities

and the government are not working at cross purposes. This could be done by the government making standardized dual purpose cask and/or concrete storage modules available to qualified utilities lease free to meet any additional storage requirements that can not be efficiently accommodated in the reactor storage pools. DOE could also provide incentives to encourage at-reactor rod consolidation based on sharing the system benefits if this is desirable. Utilities would retain full control over their choices and responsibility for all aspects of at-reactor spent fuel management activities. The Congress could go as far as paying the utility part of the cost of providing for addition at-reactor storage cost beyond a certain date without undermining the incentives to proceed with the geologic repository.

From the standpoint of overall fairness to the stakeholder the I-NO-MRS concept is clearly better than DOE's proposed I-MRS concept except for a significant UTILITY-GOVERNMENT equity problem which requires some mitigation which can be easily in accommodated in the I-NO-MRS concept without jeopardizing it's effectiveness. The utilities have a point, although very questionable, in regard to DOE's contractual commitment to start taking fuel by 1998.

G. SCHEDULING

Scheduling criteria relates to the ability to start placing waste in the geologic repository and the ability to accommodate appropriate quantities of waste. In the original I-MRS concept the principal scheduling advantage was the ability to move rod consolidation and packaging for disposal to the MRS site removing them from the critical path for licensing and operating the repository allowing more fuel to be placed in the repository earlier than might otherwise be possible. However, as the I-MRS concept evolved this potential advantage was lost according to the most recent acceptance schedules available (20) from DOE for their NO-MRS and I-MRS system configurations. This leaves the repository operating schedule criteria to the question of how does the presence of the proposed I-MRS influence the schedule. Virtually all of the stakeholders except the investor owned utilities express the view that the presence of the I-MRS in the system can undermine the political will to continue with the repository program allowing the I-MRS to become a defacto repository. This is especially true without linking MRS use to progress on the repository and there can be no effect guarantee the linkages will not be relaxed at some time in the future. The only sure way to avoid undermining the repository schedule is to not have the I-MRS in the system. It also avoids diverting DOE's attention and resources away from focusing on the repository. The I-NO-MRS is decisively better than DOE's I-MRS with regard to keeping pressure on DOE to get on with the repository program.

H. FLEXIBILITY

Flexibility is the ability of a system configuration adapt to a wide range of conditions and uncertainties yet continue to reliably preform it's intended function. Flexibility criteria can be addressed in terms of TECHNICAL and INSTITUTIONAL flexibility.

TECHNICAL - DOE's I-MRS system configuration is fragile in that the conceptual design has not been fixed because it is too dependant on uncertainties in other parts of the system. That is the question of type of package to be prepared, disposition of the western fuel, MRS location, whether rod consolidation is justifiable for disposal, and uncertainty in the effectiveness of dry rod consolidation technology. Moreover, the I-MRS is a bottleneck in the system if fuel can not be shipped to the MRS, or if the MRS operation is disrupted, or if fuel can not be shipped to the repository. The whole waste management system can fail to operate from a single cause. On the other hand the I-NO-MRS is very robust in that is a relatively simple and well defined concept which can be applied independently at each reactor site to be responsive to particular circumstances and preferences of the utility yet be effectively integrated in to the overall system. The I-NO-MRS system has great diversity and reliability, that is, each reactors storage system operates independently with little risk of common mode failure. If shipment to the repository should be suspended it will not effect the ability of the reactor to continue to operate since it does not depend on shipping fuel to the MRS for storage. From a technical flexibility standpoint the I-NO-MRS has decisively greater reliability and the ability to deal effectively with a wider range of uncertainties than does DOE's I-MRS concept.

INSTITUTIONAL - This refers to reliability in getting the system into operation and then maintaining operation in a changing regulatory and political environment. A spokesman (28) for investor owned utilities has indicated great concern about being able to get at-reactor storage licensed making reactor operation vulnerable to regulatory intervention. Limited at-reactor dry storage licensing experience does not suggest any organized opposition. In fact the broad support for at-reactor storage as an alternative to DOE's proposed I-MRS by public interest and environmental groups suggest that there is limited potential for intervention. There are, however, are no guarantees and if a utility is irresponsible in their approach to at-reactor storage they probably will have intervention. On the other hand the I-MRS is far more vulnerable to extensive delays in siting, transportation, and licensing than at-reactor storage due to intervention. The lack of a strong consensus will almost assure political instability.

The investor owned utilities have indicated that they are hopeful that the Negotiator provided for in the 1987 NWPA Amendments will find a state willing to volunteer to host the MRS and without the linkages (16). While this is theoretically possible, there seems to be no evident basis for this optimism. In the unlikely even a host can be found Congress is not likely to agree to approve a MRS without the linkages (2). Without the negotiated approach, siting a MRS facility will be controversial and probably as difficult as siting a repository. There is the possibility of repeat of the technique used to select Nevada for the first repository site, but, the success of that method is a long way from being assured. Due to the opposition to the I-MRS by the general public and public interest groups it is virtually assured that there will be intervention and political opposition to the I-MRS concept until it is withdrawn as was the case with it's precursors (RSSF and AFR). The I-NO-MRS system configuration is decisively better than DOE's I-MRS system configuration with regard institutional stability and reliability of implementation.

3. OVERALL EVALUATION

Figure V.9 provides a summary comparison of the evaluation of DOE's I-MRS system configuration and the I-NO-MRS system configuration on a relative basis. A single star (*) indicates that the system is some better than the other

FIGURE V.9 - RELATIVE COMPARISON OF VALUE CRITERIA

EVALUATIONS FOR I-MRS AND I-NO MRS SYSTEM CONFIGURATIONS

NOTE: * SOMEWHAT BETTER

* * CLEARLY BETTER

* * * DECISIVELY BETTER

CRITERIA	DOE's I-MRS CONCEPT	DUAL PURPOSE CASK I-NO-MRS CONCEPT
1. Health and Safety:		
Public		* * *
Occupational		* * *
2. Economic		* * *
3. Environmental:		
Near-term		*
Long-term		* *
4. Political:		
Acceptability		* *
Public Confidence:		
In DOE		* *
Political will		* * *
Local and State Attitudes		* *
5. Social (Fears and Anxieties)		* *
6. Fairness:		
Liability		*
Equity:		
Geographic		* * *
Intergenerational		* *
Interutility		* *
Utility-Ratepayer		* * *
Government-Utility	* *	
7. Scheduling (Repository)		* * *
8. Flexibility:		
Technical		* * *
Institutional		* * *

configuration. Two stars (* *) indicate that the system is clearly better and three stars (* * *) indicates that the system is decisively better. In this evaluation the author considered each criteria from the stand point of the customer. Since the ultimate customer is the public deference was given to views expressed in the MRS Review Commission by spokesmen close to or accountable to the public. No effort is made to apply weights to the individual criteria to provide an overall rating or ranking since this would require a value judgment of the relative importance of the criterion. The reader can, however, apply their own values to arriving at their own overall assessment. The I-MRS concept is better than the I-NO-MRS concept for only one fairness criteria which can be easily mitigated within the I-NO-MRS concept. Therefore, there is no need to get into the difficult task of evaluation that would be required if extensive trade-offs between important criteria were required. This could be a very difficult in an evaluation of no MRS system configurations based on systems integration of dual purpose cask and universal cask concepts.

The forging systems evaluation of DOE's proposed I-MRS system configuration, that has been authorized by Congress, and the I-NO-MRS system configuration, proposed by the State of Tennessee, as an at-reactor alternative based on integration of dual purpose cask into the system is used below as the basis for addressing specific impacts designated by Congress in the 1987 NWPA Amendments. The comparison includes the impact on-

(a) repository design and construction;

- Most of the stakeholders believe, except investor owned utilities, that proceeding with the MRS even with the linkages to repository progress will increase the risk the I-MRS becoming a defacto repository. There is no way to guarantee that the linkages will not be removed in response to future pressures.

(b) waste package design, fabrication and standardization;

- The design of the I-MRS and the repository are interlocked in a chicken or egg proposition. The packaging decision for the I-MRS is intertwined with the question of whether fuel should be consolidated for disposal and the repository geology. The I-NO-MRS concept is independent of disposal packaging and repository geology.

(c) waste preparation;

In the I-NO-MRS concept spent fuel would be brought to the repository as intact fuel assemblies or as compatible canisters containing consolidated fuel rods. The package configuration for the I-MRS concept is yet to be determined as indicated above.

(d) waste transportation systems;

- o The waste transportation system for the I-NO-MRS concept reduces health and safety transportation related impacts by at least 50 percent compared to DOE's I-MRS concept and without increasing the cost of transportation.

(f) the ability of the Secretary to fulfill contractual commitments of the Department under this Act to accept spent fuel for disposal;

- o It is very unlikely that the I-MRS, as authorized, will provide a means of fulfilling DOE's contractual commitments by 1998. This is also true for the I-NO-MRS concept, however, the I-NO-MRS concept can be easily adapted to providing federal assistance to utilities without undermining the commitment to a geologic repository or additional cost to the ratepayers.

(g) economic factors.

- o The total life cycle cost for the I-MRS system configuration, including additional at-reactor storage, is expected to cost about 5 billion dollars more than the corresponding cost for the I-NO-MRS concept in terms of 1986 dollars. The full cost will be paid by electric utility ratepayers through the Nuclear Waste Fund and by recover of utility expenditures for at-reactor storage through their rates.

In summary, it appears that, there is no need for a MRS facility and little, if any, utility in including the proposed I-MRS as part of the waste management system compared to the benefits of the alternative I-NO-MRS at-reactor storage concept.

REFERENCES

1. DOE, "Monitored Retrievable Storage Submission to Congress", Volume I-III, DOE/RW-0035, March 1987.

2. Leon Lowery, Environmental Action, MRS Review Commission Hearings, December 2, 1988

3. Radioactive Exchange, "NRC: DOE Should Push for Compatibility of Spent Fuel Cask Designs", November 21, 1988.

4. William W. Berry, Virginia Power Co., "Triple Purpose Cask", Nuclear Waste News, December 8, 1988.

5. Raymond E. Hoskins, "Integrated Cask Storage Systems for Storage, Transportation, and Disposal of Spent Nuclear Fuel", Waste Management '84 Conf., March 1984.

6. Westinghouse, "Preliminary Cost Analysis of a Universal Package Concept in the Spent Fuel Management System", WTSD-TME-032, SEPTEMBER 1984

7. Westinghouse and TVA, "Phase 1 Study of Metallic Cask Systems for Spent Fuel Management From Reactor to Repository", WTSD-TME-085, February 1986.

8. Carl W. Conner, DOE, "Spent Fuel Management Strategies in the United States", International SFM Workshop, October 1986.

9. Raymond E. Hoskins, U of TN, "Identification of Geographic Areas for Siting a Monitored Retrievable Storage Facility to Minimize Transportation Impacts", Waste Management Research and Education Institute, January 1987.

10. Ralph L. Keeney and Howard Raiffa, "Decisions with Multiple Objectives: Preferences and Value Tradeoffs", John Wiley & Sons, 1976.

11. U of TX, "High-Level Radioactive Waste and Spent Nuclear Fuel Disposal: An Assessment of Impact Evaluations and Decision Making Systems", Lyndon B. Johnson School of Public Affairs, 1987.

12. Woodward-Clyde Consultants, "Case Studies in Technology Choice: Tennessee Valley Authority", EPRI EA-3619 Volume 4, July 1985.

13. Raymond E. Hoskins, TVA, "TVA Systems Study: A Parametric Study of the Potential for Spent Fuel Transportation System Optimization", INMM Conf., January 1986.

14. DOE, "Initial Version: Dry Cask Storage Study", DOE/RW-0196, August 1988.

15. Steve Kraft, Edison Electric Institute, MRS Review Commission Hearings, July 27, 1988.

16. William W. Berry, American Committee on Radioactive Waste (ACORD), MRS Review Commission Hearings, December 2, 1988.

17. Raymond E. Hoskins, TVA, "A TVA View of Spent Fuel Management System Integration and Optimization", International SFM Workshop, April 1986.

18. General, MRS Review Commission Hearings, July 1988, December 1988- February 1989.

19. DOE, "Nuclear Waste Fund Fee Adequacy: An Assessment", DOE/RW-0020, June 1987.

20. DOE, "Analysis of the Total System Life Cycle Cost for the Civilian Radioactive Waste Management Program", Volume I-II DOE/RW-0047, June 1987.

21. Raymond E. Hoskins, U of TN, "Probabilist Assessment of Nuclear Waste Fund Fee Adequacy", Waste Management '88 Conf., March 1988.

22. DOE, "Initial Version: Dry Cask Storage Study", DOE/RW-0196, August 1988.

23. William F. Willis, TVA, MRS Review Commission Hearings, January 17, 1989.

24. Michael McK. Wilson, NARUC, MRS Review Commission Hearings, December 1, 1988.

25. Congressional Staff Panel, "MRS Review Commission Hearings, June 25, 1988.

26. Ben L. Smith, TN State Planning Office, MRS Review Commission Hearings, December 1, 1988 and January 18, 1989.

27. Laman Priester, SC Nuclear Waste Consultation Committee, MRS Review Commission Hearings, January 18, 1989.

28. W. G. Bill Counsil, Texas Utilities, MRS Review Commission Hearings, January 17, 1989.

30. Roy F. Pruett, Clinch River MRS Task Force, MRS Review Commission Hearings, January 17, 1989.

CRITIQUE OF DOE's MRS POSITION & MRS SYSTEMS STUDIES

1. INTRODUCTION

After the Congress amended the NWPA in 1987 to authorize an MRS facility as an integral part of the waste management system, subject to strong linkages to progress on a geologic repository, DOE decided to conduct a study of alternative system configurations with and without a MRS. The purpose of what has become known as the MRS SYSTEMS STUDIES was to assist DOE in re-assessing their position on the MRS and to provide input to the MRS Review Commission.

2. DOE's MRS POSITION

On May 25, 1989 DOE made the MRS SYSTEM STUDIES available to the MRS Review Commission and presented DOE's MRS position in hearings before the Commission. DOE continues to support an MRS facility as an integral part of the waste management system, because it would help meet DOE's strategic objectives. The MRS concept that DOE now favors is a phased approach which would not initially include rod consolidation or preparation of the final disposal package at the MRS. The MRS would receive, store and stage shipments of intact fuel to the repository, and could be later expanded to perform additional functions that may be found to be beneficial or necessary as the system design matures. To fully realize the benefits of an MRS it would be desirable to reduce the linkages between the MRS and the repository, which DOE hopes to be achieved by the Negotiator established by the Congress. However, DOE supports the MRS facility, even if the linkages are not modified.

Based on initial operation of the MRS and repository, as currently scheduled, DOE estimates that with the proposed MRS the DOE's part of the waste management system would cost $2.1 billion more than the system without a MRS. DOE estimates that availability of the MRS would reduce at-reactor storage cost by about $400 million resulting in a net system additional cost of about $1.7 billion. If the linkages to the repository were relaxed and the repository was delayed 10 years to 2013 the increase in net system cost would be reduced to about $1.3 billion based on MRS operation starting in 2000.

DOE's evaluation of other traditional criteria:

- o Health and safety,
- o Environmental impacts,
- o Socioeconomic impacts, and
- o Transportation impacts

usually used as discriminators for evaluation of alternatives do not significantly discriminate between system configurations with and without a MRS as part of the system. DOE's evaluation relies on strategic benefits related to:

- o Institutional and regulator experience with an MRS to facilitate timely disposal in a repository,

- Acceptance of fuel from utilities at the earliest possible time allowing utilities to:
  - reduce their storage cost,
  - avoid interference with plant operations, and
  - not delay reactor decommissioning.
- Providing confidence that the Federal Government is using all available means to ensure timely assumption of its responsibility to accept waste for disposal and by providing the earliest possible demonstration of acceptance, transportation and handling of spent fuel at high annual rates, and by
- Providing flexibility with respect to later decisions about waste aging and the preferred location of waste packaging functions and to the extent allowed by repository linkages provide the flexibility to adapt to an uncertain future and reduce at-reactor impacts.

The MRS system configuration proposed by DOE does not correspond to any of the options specifically analyzed in the MRS SYSTEMS STUDIES. These studies provided useful insights which were used in conjunction with analysis of other qualitative factors to assist DOE in reaching its final decision. DOE feels that the decision is primarily a public policy question in which the value of the strategic benefits obtained with an MRS outweigh the increased system cost.

CRITIQUE OF DOE's POSITION

The basis for DOE's MRS position is highly subjective. Since they could not justify the MRS in terms of traditional criteria they turned to strategic considerations to try to make their case. However, the appropriateness and value of many of these considerations are very questionable and in some instances not supported by their MRS SYSTEMS STUDIES.

It appears that DOE has elevated waste acceptance from utilities to be of equal or greater importance than progress towards disposal. There is no justification for this based on the NWPA which clearly places the responsibility for interim storage on the waste generators.

DOE places great value on confidence building by accepting, transporting, and handling waste and the experience that would be gained from building and operating a MRS. Some utility executives might be encouraged by this, but, many of the other stakeholders would see centralized storage at a MRS as a prelude to accepting defeat on the repository program. DOE's emphasis on relaxing the MRS linkages to the repository and the direction of some of the MRS SYSTEMS STUDIES suggest that DOE recognizes that the repository program is in real trouble and the MRS is being positioned as a holding action which many fear could become a defacto repository.

The same basic technology available for use at the proposed

MRS with a wide range of adaptability to particular situations is available to permit utilities to reliably, safely and economically provide for life-of reactor storage if necessary. The No-MRS system configuration developed for the State of Tennessee offers a higher degree of overall system reliability and flexibility than the MRS option proposed by DOE at a lower cost and greater public acceptance.

While cost should not be the determining factor in selection the preferred waste management system configuration, it is not unimportant to the electric ratepayer. DOE's cost estimates are based on preliminary conceptual designs for facilities that have never been licensed, built, or operated. Experience with such nuclear related facilities of a controversial nature suggest that there is a real possibility of major cost increases after it is decided to proceed with the facility. DOE acknowledges that there might be 10 to 20 percent uncertainty in their estimates. More realistically the MRS system is more likely to cost two or three times DOE's estimates.

DOE may also be overestimating the MRS storage benefits to utilities since DOE appears to be overestimating the amount of spent nuclear fuel that is likely to be produced and underestimating the utilities ability to expand in-pool storage capacity if they fine it necessary. DOE also appears to be overestimating the differential cost between providing storage at the MRS and at-reactor storage.

DOE has not adequately considered system configurations based on at-reactor storage as an alternative to the proposed MRS system configuration. The MRS SYSTEMS STUDIES is not the application of systems engineering to develop, optimize, and evaluate alternative system configurations as the name might suggest. It is actually a comparative evaluation of nine pre-defined system configurations which evaluates the split of fuel packaging functions between the MRS and the repository with a strawman No-MRS system configuration included for comparison. The primary focus from a systems standpoint is on the question of whether to consolidate fuel prior to disposal and if it is to be consolidated should the operation be performed at the MRS or the repository. Whether to perform final waste packaging at the MRS or the repository is also examined. The study is useful in examining these question but provides little in the way of useful analysis of the No-MRS options. In testimony before the MRS Review Commission DOE represented that their comparisons were based on the optimum No-MRS case. Examination of the MRS SYSTEM STUDIES indicate that none of the system configurations were optimized.

One of the MRS Commissioners asked if DOE had given any consideration to the work brought fourth by the State of

Tennessee in studies since 1987, particularly related to systems based on use of dual purpose cask. DOE indicated that they think it is a mistake to mix up considerations over dual purpose cask with whether or not there is an MRS. DOE sees these as separate distinct issues, which are both important objectives, but don't have any impact on one another. That clearly is not the case as has been shown in this report for the State of Tennessee. DOE has consistently refused to give any meaningful consideration to this approach to optimization of a No-MRS system configuration.

3. MRS SYSTEMS STUDIES

The following sections of this addendum is devoted to review of the MRS SYSTEM STUDY documents. The study was conducted and documented as ten tasks as follows:

Task A - Appendix A: Assumptions for MRS Systems Studies

Task B - Facility Design

Reference - Analyses of Alternatives Designs and Operating Approaches for a Monitored Retrievable Storage Facility

Task C - Storage Concepts for the MRS-Facility

Re-evaluation of Monitored Retrievable Storage Concepts

Task D - HLW Packaging Location

Task E - Waste Package Design

Task F - Transport Impacts of a Monitored Retrievable Storage Facility

Task G - The Role and Functions of Surface Storage of Radioactive Material in the Federal Waste Management System

Task H - Licensing

Task I - Waste Management System Reliability Analysis

Task J - MRS System Study Summary Report

The full set of documents contain several thousand pages much of which is not relevant to the issue of whether to have a MRS in the system, therefore a detailed critique of the these reports would be of limited usefulness. Moreover, DOE's justification of their position in support of the MRS is based primarily on strategic considerations rather than technical aspects of the waste management system. DOE has stated on several occasions

> "The decision on whether or not an MRS facility should be pursued rest more on the vision of how its program objectives can best be achieved, and this decision is supported, but not driven by considerations of a technical optimization and cost."

It has been difficult for others to grasp a clear view of DOE's vision and the values to be used in designing and managing the waste management system. Many of the stakeholders apparently do not share DOE's vision and continue to believe that technical optimization and cost should play an important role in gaining credibility and public acceptance for the waste management system. The following sections of this chapter is critique of selected parts of the MRS SYSTEM STUDIES that should be relevant to the question of whether or not a MRS should be part of the system.

TASK C - RE-EVALUATION OF MONITORED RETRIEVABLE STORAGE CONCEPTS

In 1983 nine storage concepts were evaluated for use at a MRS facility resulting in the selection of concrete cask as the preferred concept with the field drywell as a backup. Teams of experts were used in conjunction with Delphi techniques and hiearchical analysis to conduct the evaluation. Storage concepts were rated against seven criteria, and weighted composite ranking were developed to define the order of preference. The criteria and weighting factors used were:

Safety and Licensibility	43%
Environmental Impact	11%
Socioeconomic Impact	5%
Siting Requirements	9%
Cost	10%
Concept Maturity	12%
Flexibility	10%
Total	100%

Since there have been several programmatic changes it was decided to review the earlier selection. Water pool storage and the horizontal modular storage vault (NUHOMS system) were added to the evaluation. Rather than repeating the expert-based examinations use earlier the re-evaluation was conducted by a small group that focused on changes that had taken place while retaining the criteria and weighting factors from the initial evaluation. Results of the re-evaluation in the order of preference for concept selection was:

1		Concrete Cask
2		Field Drywell
3		Open-Cycle Vault
4		Water Pool
5	tie	Stationary Metal Cask
5	tie	NUHOLMS Horizontal Vault
7		Concrete Cask-in Trench
8		Transportable Metal Cask (Dual Purpose Cask)
9		Closed-Cycle Vault
10		Tunnel Drywell
11		Tunnel-Rack Vault

the concrete cask and field drywell were ranked first and second respectively as in the previous evaluation. The combination of low cost, adaptability, and confidence in prediction of both cost and performance entered highly into affirmation of this choice. The Transportable Metal Cask or Dual Purpose Cask was ranked eighth in the order of preference due to high cost and a low licensing rating. Despite its higher cost the transportable storage cask would be unexcelled as a choice for storage in the first phase of MRS operations: concrete cask or another concept would be used in later phases.

TASK C - CRITIQUE

A family of transportable storage cask or dual purpose cask effectively integrated into the waste management system is the basis of No-MRS waste management system configuration that is proposed in this study for the State of Tennessee as an alternative to DOE's proposed Integral-MRS. These would be used primarily for storage at reactor sites. However if there is extended delays in repository operation it might be desirable to move some cask to temporary storage at one or more simple MRS facilities to permit reactor decommissioning to begin. The results of DOE's evaluation of MRS storage suggest that the dual purpose cask would be a poor choice for use at a MRS facility and perhaps for at-reactor storage.

The methodology used in developing the composite ranking of storage concepts is inherently biased against any concept that is judged to be less than the first rank with regard the safety and licensing since this criteria carries almost half of the total weight. Moreover, the downgrading of the transportable metal cask, due to the lack of licensing experience and questions relating to certification of a cask for transport service following an extensive period in storing spent fuel appears to be inappropriate.

While DOE has some experience with concrete cask and field drywells they have never been subjected to NRC review and licensing as they would be used at the proposed MRS. There appears to be no technical basis that either the fuel or the transportable metal cask would deteriorate during storage. The basis for the recertification question appears to be based on the assumption that the transportable metal cask would need to be certified and recertified for transportation by NRC as though the cask was in use in general commerce for fuel shipments similar to transport cask. This would be neither desirable or necessary. If extensive use of dual purpose cask were to become the basis for spent fuel management until the repository is available NRC would be petitioned to develop regulations appropriate to the particular use of these cask in the waste management system.

The cost analyses in DOE's evaluation greatly overstates the expected the increase in cost of transportable metal cask over concrete storage cask. There is considerable uncertainty in what the actual cost of either concept would be under the circumstances relating to it use. While DOE's estimates are within the range of possibilities for both concepts the reference values used in the analysis is probably on the low side of the expected value for concrete cask and on the high side for transportable metal cask. There is no relevant actual cost experience for the concrete cask. There is, however, actual experience that has some relevance for transportable metal casks. The Federal Republic of Germany has adopted the transportable metal cask for use at their MRS and has successful marketed a version of this cask in the United States for storage. While it has not been licensed for transport it is designed to be transportable as is a number of other large storage cask. These cask have been sold for storage for about $800,000. Produced in large numbers in a competitive market should result in some reduction in cost which would be partially off-set by an increase in cost to license the cask for transportation. On this basis transportable storage casks would have a mean or expected cost of about $700,000 each. DOE's evaluation uses a cost of $1,250,000 each based DOE estimates for transportation cask procurement adjusted to reflect some savings in licensing cost and no credit for large scale procurement. DOE's analysis rationalizes that there might be a penalty for large scale procurement since it would be necessary to purchase a large number of a cask over a short period. That might be the case if the cask were only used at the MRS. However, it would seem more reasonable to purchase these cask earlier for at-reactor use before they are moved to the MRS.

<u>TASK F - TRANSPORTATION IMPACTS OF A MRS FACILITY</u>

This analysis considered two basic waste management system configurations, one without an MRS and one with an MRS. Variations in MRS functions considered were:

- o STORAGE ONLY.
- o CONSOLIDATION, CANISTER, AND STORAGE.

- CONTAINERIZE INTACT FUEL, AND STORAGE,
- CONSOLIDATE, CONTAINERIZE, AND STORAGE, AND
- CONSOLIDATE . CONTAINERIZE, AND STORAGE.

Containerization of the fuel indicates preparation of the repository ready disposal package while canistering the fuel indicates use of an intermediate package that would be placed in the disposal container at the repository. The effects of Eastern or Western generic MRS locations were examined together with a strategy in which fuel from western reactors is shipped directly to the repository rather than to an Eastern MRS.

Important assumptions were:

- From-Reactor shipments is split about 55% by rail and 45% by truck based on use of rail where there is rail access to the reactor loading bay and the reactor has adequate crane capacity.
- From-Reactor rail cask have a capacity of 21 PWR or 48 BWR (about 9 metric tonnes per shipment) intact fuel assemblies with a nominal loaded cask weigh of 100 tons. For the first time, DOE has assumed these cask would be shipped by special dedicated train with three cask per shipment based on the nominal annual reactor discharge rate.
- Truck cask have a capacity of 3 PWR or 7 BWR intact fuel assemblies (about 1.3 metric tonnes per shipment) with a gross weight of 28 tons. Sensitivity analysis were

performed based on use of overweight truck cask with a gross weight of 40 tons.

- Cask used for shipment from the MRS to the repository vary in gross weight from about 125 tons to 150 tons (cask load range from about 5 to 25 metric tonnes) depending on the fuel form being shipped. All shipments are by special dedicated train assuming five fuel cask per shipment.

Results of the analysis are presented in terms of cost, dose, and ~~three~~ four proxy measures of transportation activity. The proxy measures used were:

1. Shipment-Miles,
2. Cask-Miles,
3. Cask-Days, and
4. MTU(metric tonnes of uranium)-Miles.

Results of the analysis indicate that total transportation cost range from $634 for an Eastern MRS that consolidates and canisters fuel in conjunction with shipping western fuel directly to the repository to $1,120 million for an Eastern MRS that containerize intact fuel compared to $832 million for DOE's No-MRS case. Total transportation radiological dose ranges from 1,400 person-rem for an Eastern MRS that consolidates and canisters fuel with western fuel being shipped directly to the repository to 2,600 person-rem for a Western MRS that containerizes intact fuel compared to 2,600 person-rem for DOE's No-MRS case. The previously mentioned transportation proxy measures were compared for the various cases considered and the location (West Virginia) at which the shipment-mile measure is minimized was determined as the location that would minimize transportation impacts.

The report concludes in general, that from a transportation standpoint, the MRS is economical more favorable than a No-MRS system when its packaging function maximizes MRS to repository cask capacity and minimizes reactor to MRS shipment-miles. From a radiological perspective it is concluded that an Eastern MRS provides a dose reduction of 25% to 45% over a Western MRS (depending on selection of packaging function) or a No-MRS system, because of the reduced number of cross-country shipments. In the worse case (No-MRS) there is estimated to be about 0.5 latent-cancer fatalities for all shipments which compares to roughly 5,000 latent-cancer deaths per year in the United States from background radiation. Nonradiological transportation risk was not calculated in the analysis, although, it was indicated that such risk is much higher than the radiological risk.

TASK F - CRITIQUE

From a technical perspective this appears to be the best transportation analysis that DOE has performed. The principal criticisms of this analysis is related to the assumptions that were made rather than the methodology used. From a methodological standpoint it would have been more accurate to use cask-days rather than shipment-miles as the proxy measure for determining the best MRS location to minimize transportation impacts. The assumptions made about the from-reactor transportation system is all important in determining the relative transportation cost and dose for waste management system configurations with and without a MRS in the system.

The analysis acknowledges that cask capacity may be the most important determinant of transportation cost and dose. Substantial improvements in the capacity of from-reactor transportation cask were assumed compared to previous studies. These improvements appear to be based on what DOE believes can be achieved by optimizaton of transportation casks currently being developed. Further improvement in the from-reactor transportation system has been made through the use of multiple cask shipment by special dedicated train rather than single cask shipment in general commerce. However, the results of the analysis is completely dominated with regard to cost and dose by the assumed modal mix between rail and truck shipment (55% rail and 45% truck) due to the relative low capacity of truck cask.

The study did not include an analysis of the transportation system that has been suggested by work for the State of

Tennessee which utilizes 100% multiple cask shipment by special dedicated train in conjunction with the largest cask practical at each reactor from a family of dual purpose cask ranging in gross weight from 25 tons to 150 tons. Nothing in DOE's current transportation system analysis is persuasive in indicating that the all rail transportation system that has been suggested would not be just as cost effective as a system with an MRS and at substantial reductions in transportation risk.

In formulating their policy position in support of the MRS DOE undertakes to defuse the transportation issue by declining to specifically claim health and safety benefits due to reduced transportation risk or other transportation impact reductions as being attributed to having a MRS in the system. DOE now believes that the transportation risk are very small in absolute terms and do not discriminate between MRS and No-MRS options. DOE also indicates that, regardless of MRS location, the net transportation benefits do not significantly discriminate between the MRS and No-MRS options. DOE indicates that this conclusion is supported by the State of Tennessee's detailed transportation analysis which concluded that "the radiological risk of all alternatives studied is very small" and the choice between alternative nuclear waste disposal systems should not rest on transportation handling cost or risk".

Within the technical nuclear community it is generally accepted that spent fuel transportation risk are small in absolute terms. However, public perceptions and public officials concerns about spent fuel transportation are quite different and is a reality that must be acknowledged and satisfactory reconciled. While transportation risk are small they are very important and every reasonable effort should be made to minimize transportation risk and other impacts on the public. DOE's quotation of the States of Tennessee's work is out of context which held that the transportation system should be optimized to minimize transportation impacts irrespective of whether or not there is an MRS in the system.

TASK H - LICENSING

The Licensing Study addresses two specific questions:

1. Could any unforeseen licensing problems arise if a decision were made to produce the disposal container at the MRS and then ship it to the repository?, and
2. Could any schedule improvements be achieved in repository licensing by use of an MRS facility to simplify the repository licensing process to largely underground concerns?

Conclusions from this analysis indicate that:

- o From the viewpoint of licensing a total waste disposal system the No-MRS scenario provides the simplest licensing effort.
- o Containerization of waste for disposal at the MRS will

have to wait for an advanced stage (if not the conclusion) of the repository construction authorization review in order to determine whether NRC will approve the proposed container. The disposal container is part of the overall containment and isolation system of the repository. As such, the disposal container will be reviewed by the NRC for compliance with performance objectives for containment and isolation. Such review cannot be conducted during the MRS review well in advance of the repository review.

- The analysis indicate that the licensing time for the repository is essentially unaffected by any MRS scenario due to the linkage requirements in the NWPA, as amended. Such linkage leads to parallel review of license application, as well as simultaneous construction.
- A simple storage only MRS provides the simplest licensing effort for an MRS, although it does not reduce (or increase) the schedule for the repository.
- If the linkages between the MRS and repository are removed allowing operation of the MRS at an earlier date the repository licensing schedule would be unaffected. The burden on resources for both agencies would be somewhat diminished if the reviews are conducted in series rather than parallel. The experience of DOE in an earlier MRS licensing process

may assist in more efficient participation in repository licensing.

TASK H - CRITIQUE

DOE's policy position in support of the MRS appears to claim greater benefits for timely disposal in a geologic repository due to having an MRS in the system than appears to be justified from the results of this licensing analysis. This analysis is very weak support, at best, for DOE's claims which appear to rely entirely on removal or significant modification of the MRS-repository linkages.

TASK I - WASTE MANAGEMENT SYSTEM RELIABILITY ANALYSIS

In this study, reliability is defined as the ability to accomplish two major waste system functions:

- waste acceptance from generators, and
- waste disposal in the geologic repository

in accordance with the OCRWM Mission Plan (DOE 1985). For each of these functions DOE requested that reliability be examined from the standpoint of

1) the ability to start each function on schedule, and
2) the ability to successfully carry out each function at the Mission Plan operating rates once startup is achieved.

Due to time and study constraints analysis is limited to two system configurations. The first system features a full-function MRS that receives, stores, consolidates and canisters spent fuel and sends it to a repository for containerization and disposal. The second system is a comparable repository-only system that receives, consolidates, and containerizes spent fuel at the repository before placing it underground for disposal. The scope of the analysis is limited to reliability of the waste acceptance and disposal functions and does not include transportation system reliability.

It was not possible, at this time, to directly estimate reliabilities for the various system configurations. reliabilities for the conceptual designs were approximated based on indirect indicators. These indicators are excess lag storage capacity and functional idle time. Excess lag storage capacity is the amount of in-process storage available at various points in the system to ensure continuous smooth operation at other functions when one function is not able to operate. Function idle time represents the additional time that could be worked if additional throughput were desired.

Results of the analysis indicate that:

- the MRS system analyzed has significantly greater potential for assuring that the federal system will be able to accept waste as scheduled than a repository-only system, and
- the reliability of waste disposal is essentially the

same for the two systems because the same geologic site requiring the same licensing and acceptance activities and employing the same equipment is used for both systems.

Reliability of waste acceptance is improved by limiting the constraints (MRS-repository linkages) imposed by the NWPA. The MRS has several operational advantages that enhance system reliability:

1) the MRS siting, design, and licensing process is less likely to encounter technical issues - such as unanticipated geologic characteristics - that could delay or interrupt waste acceptance,
2) the MRS would assure adequate system surface storage capacity to accommodate repository construction and start-up delays of up to five years, or longer if the NWPA were amended,
3) the MRS system has two acceptance facilities in the federal system with parallel transportation routing and surface storage capacity, and
4) the MRS system would allow continued waste acceptance for up to a year after a major disruption of emplacement operations at the repository.

TASK I - CRITIQUE

The basis for this reliability analysis appears to elevate waste acceptance from the generators for storage to the same or perhaps higher importance in waste system functions than disposal. While the generators might be appreciative of this priority it is not consistent with the NWPA. The Findings And Purposes of the NWPA clearly places the responsibility for permanent disposal on the Federal Government and places the primary responsibility to provide for and pay for interim storage on the waste generators and owners until accepted for disposal. Moreover. NWPA Sec. 302 pertaining to contracts limits waste acceptance until after commencement of repository operation. The 1987 NWPA amendments authorized a MRS facility as an integral part of the waste management system subject to linkages to progress on placing the repository in operation which are intended to prevent the MRS from becoming a defacto repository and essential preserves NWPA waste acceptance restrictions.

Waste acceptance independent of disposal is not an appropriate objective in the design and evaluation of alternative waste management system configurations. However. interim storage of waste until accepted for disposal provided through any combination of at-reactor storage, away-from-reactor storage, MRS, or lag storage at the repository is an essential part of the overall waste management system as is any transportation or processing (handling, consolidation and packaging) requirements required for interfacing of these system components. Reliability is an important attribute in evaluation of alternative system configurations. The reliability analysis presented in this task is incomplete in that it does not consider at-reactor storage, fuel handling, or transportation which can have a profound effect on overall system reliability.

There does not appear to be meaningful experienced based data for dry rod consolidation, fuel handling, packaging, and storage operations that have been propose in the MRS conceptual design. It is not a question of technical feasibility, but one of how well the processes will work and experience necessary to refine them to perform as designed. These are the kind of operations that can present many unanticipated problems between the current conceptual design phase and fully functional operation. The reliability of these operations and the amount of excess capacity that might be available in current conceptual designs is largely conjecture.

An important systems design reliability principal, "Operational reliability of a system is dependent on the number of consecutive serial processes required in the system.", is recognized and used in the analysis to provide a lower bound on various MRS configurations. That is, the reliability of the MRS will decrease in relation to the number of functions performed at the MRS. This important principal seems to have been ignored in comparing the reliability of the No-MRS and MRS system configurations. From this standpoint the No-MRS system is inherently more reliable since it involves fewer serial operations between discharge of the fuel to emplacement in the repository. Diversity is another important principal used to design reliability into a system by dividing important functions into a number of parallel operations. This principal also favors the No-MRS system configuration with at-reactor storage to reliably provide storage until disposal begins at the repository.

RICHARD BRYAN
NEVADA

Ms. File — MRS (TN Nuclear Fres).

KM

COMMITTEES:
BANKING, HOUSING, AND URBAN AFFAIRS
COMMERCE, SCIENCE, AND TRANSPORTATION
JOINT ECONOMIC

United States Senate

WASHINGTON, DC 20510-2804

Logged in 6/24

June 20, 1991

Dear Colleague:

I am writing to bring to your attention my concerns about S.1138, legislation reported out of the Senate Energy Committee last week. The bill purports to preempt all of Nevada's environmental laws and regulations over the Department of Energy's efforts to characterize Yucca Mountain for suitability as a high level nuclear waste dump. Such an unprecedented preemption is unwise, unnecessary, and would set a dangerous example for the difficult tasks DOE will face over the next decade in siting other controversial waste treatment and disposal facilities to address the massive quantities of waste in the DOE nuclear complex.

S.1138 would exempt all site characterization activities for the high level waste program from all Nevada state, local or tribal laws. It also restricts Nevada's access to the court system, and removes existing linkages in the Nuclear waste Policy Act to allow for the immediate siting and construction of a Nonitored Retrievable Storage facility for nuclear waste. The premise of the legislation is that without exemption from all state law, this project would be subject to continuing delays. That premise is inaccurate and misleading for the following reasons:

1) Although DOE has claimed that this program would be on track but for the actions of Nevada since the 1987 amendments to the Nuclear Waste Policy Act, the GAO has recently testified that:

"Nevada's refusal to provide permits did not affect new on-site construction work until February 1991 because DOE was not ready to begin this work until then."

Now that the Supreme Court has rendered a decision relative to Nevada's attempted veto of the site, the permitting process is moving forward under the supervision of the federal District Court, and the first of the requested permits was issued by the State of Nevada.

2) The legislation is unnecessary. In recent testimony the EPA has indicated existing authority to waive state requirements already exists in the three federal environmental statutes that would most likely be affected by this legislation--the Clean Air Act, Clean Water Act, and the Resource Conservation and Recovery Act. Yet the administration has not attempted to exercise its existing authority, thus shifting the burden of this decision to

the Congress. Congress need not, and should not, set the precedent of eliminating state environmental laws, especially when existing administrative authority exists--and the permitting process is going forward.

3) Finally, DOE and the nuclear industry made a fundamental mistake in putting all the Nation's high-level waste eggs in the Nevada basket, and this legislation would only further poison relations with Nevada and its citizens and strengthen their resolve to prevent the development of the repository. It is also diametrically opposed to the philosophy behind recent efforts to open DOE to greater independent oversight and mandate environmental compliance with state and federal regulations.

As the enclosed speech by the Honorable Joseph Rhodes Jr., a Public Utility Commissioner of the State of Pennsylvania, indicates, other approaches should be considered to this issue. In any event, now is not the time to set a dramatic and unneeded precedent while the mandated process is moving forward.

I would be happy to discuss this matter with you at any time, and I do hope you read the attached speech by Commissioner Rhodes.

Sincerely,

RICHARD H. BRYAN
United States Senator

Speech by
the Hon. Joseph Rhodes Jr.
Public Utility Commission
State of Pennsylvania

Proposing an alternative
to the current plan
to dispose of
high-level nuclear waste
at Yucca Mountain

November 13, 1990
Orlando, Florida

COMMENTS OF JOSEPH RHODES, JR.
AT THE 102nd ANNUAL CONVENTION OF NARUC
ORLANDO, FLORIDA NOVEMBER 13, 1990

NUCLEAR POWER: WASTE DISPOSAL, NEW REACTOR TECHNOLOGY

" PYRAMIDS UNDERGROUND "

THIS MORNING AS I LOOK AROUND AT THIS DISTINGUISHED PANEL ABOUT TO ADDRESS THIS COMPLEX AND IMPORTANT PAIR OF SUBJECTS, I MUST CONFESS THAT THE THOUGHT THAT RUNS THROUGH MY MIND IS A RATHER SIMPLE ONE: "HOW DID I GET HERE?"

HOW DID I GET HERE? I DO NOT SIT ON THE NARUC ELECTRICITY COMMITTEE AND HENCE NOT ON THE SUBCOMMITTEE ON NUCLEAR ISSUES - WASTE DISPOSAL. THIS PANEL PRESENTATION TODAY REPRESENTS THE FIRST CHALLENGE I HAVE HAD AS A PENNSYLVANIA COMMISSIONER TO THINK ABOUT THESE ISSUES IN A DETAILED AND NATIONAL WAY. AFTER I'M FINISHED, I HOPE YOU WON'T GO AWAY MUTTERING "WHO WAS THAT GUY ANYWAY?"

I SUSPECT I RECEIVED THIS ASSIGNMENT FOR A SIMPLE REASON. AT THE LAST MEETING OF THE FINANCE AND TECHNOLOGY COMMITTEE IN LOS ANGELES I HAPPENED TO ASK BRUCE MORRISON OF WESTINGHOUSE A FEW TECHNICAL QUESTIONS ABOUT THE AP600. IN OTHER WORDS MY PRESENCE HERE TODAY IS A PRACTICAL MANIFESTATION OF THE ADAGE: "NO GOOD DEED SHOULD GO UNPUNISHED." GERRY GUNTHER, I'M GOING TO GET YOU WHEREVER YOU ARE.

AS I PREPARED FOR THIS PRESENTATION I REFLECTED ON THE EXPERIENCES THAT I HAVE HAD THAT HAVE SHAPED MY VIEWS ON NUCLEAR POWER. EARLIER THIS YEAR THE PENNSYLVANIA COMMISSION RENDERED A DECISION IN THE LIMERICK II RATE CASE, UNDOUBTEDLY THE MOST

RECENT NUKE-GOING-INTO-RATE-BASE CASE IN THE COUNTRY AND PROBABLY ONE OF THE LAST OF SUCH CASES IN THIS CENTURY. OVER THE PAST YEAR I HAVE LEARNED MORE ABOUT MARK II CONTAINMENT AND CRUD INDUCED LOCALIZED CORROSION THAN I EVER WANTED TO KNOW.

THE VERY FIRST ISSUE I TOOK UP WHEN I CAME ON THE COMMISSION IN 1988 WAS THE SITUATION AT PEACH BOTTOM AND THE EFFORTS BY PECO TO "JUMP START" THE REACTOR LONG BEFORE THEY WERE REALLY PREPARED TO DO SO. AS IT TURNED OUT THE SCHEDULE WAS LENGTHENED, AND SO FAR THINGS SEEM MUCH IMPROVED AT THIS STATION FORTY MILES DOWN RIVER FROM THREE MILE ISLAND.

THREE MILE ISLAND, NOW THERE WAS A FORMATIVE EXPERIENCE. I LIVED THROUGH THREE MILE ISLAND ON A PERSONAL LEVEL. I WAS THERE. THE CONTEMPLATION OF NUCLEAR DISASTERS IS NOT AN ABSTRACT EXERCISE FOR ME. IN MY LAST TERM AS A STATE REPRESENTATIVE, I HEARD THE SIRENS IN THE CAPITAL COMPLEX GO OFF TO WARN US TO CLOSE OUR WINDOWS BECAUSE ANOTHER BIG RELEASE HAD JUST ESCAPED FROM THE REACTOR. MY HOME IN PITTSBURGH WAS FILLED WITH FRIENDS FROM HARRISBURG WHO WERE ONLY PART OF THE TENS OF THOUSANDS WHO VOLUNTARILY EVACUATED CENTRAL PENNSYLVANIA WHILE GOVERNOR THORNBURGH AND THE NRC TRIED TO CALM EVERYONE DOWN WITH WHAT TURNED OUT TO BE A GROSS UNDERASSESSMENT OF THE EXTENT OF THE ACCIDENT.

THOUGH YOU MIGHT THINK OTHERWISE AT THIS POINT, I DON'T CONSIDER MYSELF EITHER PRO- OR ANTI-NUKE. THE DREAM OF BECOMING A NUCLEAR ENGINEER WAS THE SUSTAINING VISION THAT GOT ME OUT OF THE INNER CITY. I CAN STILL SEE DR. WILLIAMS AT THE UNIVERSITY

OF VIRGINIA REACTOR FACILITY IN THE SUMMER OF 1964 DRILLING US NATIONAL SCIENCE FOUNDATION HIGH SCHOOL STUDENTS WITH TWO GROUP REACTOR THEORY. LATE AT NIGHT I WOULD LOOK DOWN INTO THE REACTOR POOL, AND FASCINATED WITH THE EERIE BLUE GLOW OF THE CHERENKOV RADIATION, I WOULD DREAM OF SOMEDAY RUNNING A BIG POWER REACTOR.

I DON'T BELIEVE ONE SHOULD BE IDEOLOGICAL ABOUT TECHNOLOGY. I DO, HOWEVER, BELIEVE THAT GIVEN THE POTENTIAL FOR CATASTROPHIC AND VIRTUALLY PERMANENT ENVIRONMENTAL DAMAGE FROM NUCLEAR OPERATIONS, WHEN IN DOUBT WE SHOULD ERR ON THE SIDE OF CAUTION WHEN IT COMES TO NUCLEAR POWER. IN MY BOOK, NUCLEAR PROPONENTS HAVE A HEAVY BUT NOT INSURMOUNTABLE BURDEN OF PROOF TO SATISFY BEFORE THEY CARRY THE DAY.

NOW, WHAT ABOUT "WASTE DISPOSAL AND ADVANCED REACTOR DESIGNS"? OF THE TWO ISSUES, TO ME, THE FORMER IS MORE CRITICAL THAN THE LATTER. IF WE DON'T SOLVE THE WASTE PROBLEM, IT WON'T MATTER IF A PASSIVELY SAFE, STANDARDIZED NUCLEAR POWER SYSTEM IS DEVELOPED. THIS IS TRUE EVEN IF THE NEW DESIGNS INCLUDE, AS I AM LED TO BELIEVE THEY DO, ENOUGH ON-SITE STORAGE CAPACITY FOR THE USEFUL LIFE OF THE STATION. EVENTUALLY THE STATION WILL BE DECOMMISSIONED AND THE WASTE REMOVED TO A PERMANENT SITE. AND JUST HOW PERMANENT IS "PERMANENT"?

IT IS NOW THE END OF 1990. WHAT WILL LIFE BE LIKE IN THE YEAR 12,000? WHAT WAS LIFE LIKE IN 8,000 B.C.? THE TIME SPAN OF 10,000 YEARS ENCOMPASSES ALL OF RECORDED HUMAN HISTORY. ALL WE KNOW FROM 10,000 YEARS AGO WE DECIPHER FROM GEOLOGIC SEDIMENTS AND WASTE HEAPS. THE PERIOD OF 10,000 YEARS IS RELEVANT BECAUSE

THAT'S HOW FAR OUT THE EPA REGULATIONS CURRENTLY CALL FOR A MEASURABLE LIMIT OF GROUND WATER CONTAMINATION FROM HIGH LEVEL WASTE STORED IN THE PERMANENT REPOSITORY. GIVEN PROBABILISTIC RISK ASSESSMENT, TIME HORIZONS OF SUFFICIENT LENGTH AND SUFFICIENTLY UNACCEPTABLE OUTCOMES, YOU MAY NOT BE ABLE TO GET THERE FROM HERE WITH KNOWN OR EVEN IMAGINED TECHNOLOGIES AND GEOLOGICAL SITES. TO PARAPHRASE THE BARD: "THAT'S THE RUB."

AND THE PROBLEM OF TIME HORIZONS IS EVEN WORSE. WHEN WE TALK ABOUT BUILDING A PERMANENT SITE FOR HIGH LEVEL NUCLEAR WASTE DISPOSAL, WE ARE ACTUALLY TRYING TO DEVELOP A STRUCTURE BEFORE 2010 WHICH WILL LAST EONS OF TIME LONGER THAN KNOWN HUMAN HISTORY AND PROTECT THE HUMAN POPULATION FROM ITS EXISTENCE THROUGHOUT THAT PERIOD. THIS PLAN IS TANTAMOUNT TO CONSTRUCTING AN UNDERGROUND FACILITY WITH THE DURABILITY OF THE PYRAMIDS. WE ARE TALKING ABOUT BUILDING THE MODERN EQUIVALENT OF "PYRAMIDS UNDERGROUND." CAN YOU IMAGINE THE ARCHAEOLOGISTS OF 12,000 A.D. SCRATCHING AT THE HIEROGLYPHICS OF A NUCLEAR WASTE REPOSITORY WONDERING WHAT THE SYMBOLS MEAN?

THE QUESTION OF NUCLEAR WASTE THAT MUST BE ANSWERED IS: GIVEN CURRENT TECHNOLOGIES, EARTH SCIENCES, THE LAW OF THE LAND AND POLITICS, CAN A SAFE, PERMANENT REPOSITORY FOR HIGH LEVEL WASTE BE BUILT IN A REASONABLE PERIOD OF TIME? THIS IS THE $64 QUESTION FOR REGULATORS, SCIENTISTS, THE INDUSTRY, RATEPAYERS AND THE PUBLIC.

TO A REGULATOR WHO MUST SET ELECTRICITY RATES, THIS IS MORE THAN A CURIOSITY. IT IS A MEGA BUCK CALAMITY. AS OF JUNE 30,

1990 ALMOST $7 BILLION HAD BEEN CONTRIBUTED BY UTILITIES AND THEIR RATEPAYERS TO THE NUCLEAR WASTE FUND IN THE U.S. TREASURY. SINCE ITS INCEPTION, $2.7 BILLION HAS BEEN DISBURSED FROM THE FUND FOR DOE USE FOR RESEARCH AND DEVELOPMENT, ROUGHLY A BILLION OF THAT HAVING GONE INTO YUCCA MOUNTAIN. SO THE REMAINING $4.3 BILLION IS BEING USED TO OFFSET THE FEDERAL DEFICIT JUST LIKE THE SOCIAL SECURITY FUNDS. IN ADDITION, DOE HASN'T CONTRIBUTED THE $483 MILLION IT OWES TO THE NUCLEAR WASTE FUND. DO YOU THINK THEIR CONTRIBUTIONS MADE IT INTO THE DEFICIT REDUCTION PACKAGE? IT IS ESTIMATED THAT THE TOTAL COST TO ESTABLISH THE HIGH LEVEL WASTE DEPOSITORY MIGHT APPROACH $40 BILLION.

AND THIS IS THE GOOD NEWS. THE DECISION TO PUSH BACK THE ACTIVE DATE OF THE PERMANENT REPOSITORY HAS NECESSITATED AN INTERIM SOLUTION: EXPANDED ON-SITE STORAGE AND THE MONITORED RETRIEVABLE STORAGE PROGRAM. THE ESTIMATES FOR STORING THE WASTE ESSENTIALLY TWICE VARY SO MUCH I REALLY COULDN'T GUESS HOW MUCH THE MIL/KWH CHARGE WILL RISE IN THE NEAR FUTURE.

ARE WE MAKING RATEPAYERS PAY FOR SOMETHING THAT WILL AMOUNT TO THE UTILITY REGULATOR'S NIGHTMARE: A PHANTOM FACILITY THAT COSTS MORE AND MORE EACH YEAR BUT NEVER GETS BUILT OR USED?

ALL OF US KNOW THAT TIME IS MONEY. IN 1982 WE PROMISED TO COLLECT THE DOLLARS FOR DEVELOPMENT, AND THE FEDS PROMISED TO HAVE A FACILITY IN PLACE TO RECEIVE THE WASTE IN 1998. THEY HAVE NOT LIVED UP TO THEIR SIDE OF THE BARGAIN. IN THE SIX YEARS FROM 1983 TO 1989 THE ESTIMATED COST OF THE NUCLEAR WASTE PROGRAM HAS ESCALATED 60%, OF WHICH 1/3 IS DUE TO INFLATION, BUT DOE'S

CURRENT ESTIMATE CONTAINS NO CONTINGENCY FOR FUTURE ESCALATION OTHER THAN INFLATION.

WILL THE FIRST PERMANENT REPOSITORY BE BUILT BY 2010, THE CURRENT SCHEDULE? AND MORE IMPORTANT: WILL IT BE BUILT AND LICENSED IN YUCCA MOUNTAIN, NEVADA? THIS IS THE REAL QUESTION BECAUSE THE CURRENT STRATEGY SEEMS TO BE YUCCA MOUNTAIN OR BUST, AN ALL OR NOTHING BET.

A MAJOR FACTOR IS THE LEGAL QUESTION. TWO MONTHS AGO, IN NEVADA VS. WATKINS, THE NINTH CIRCUIT SHREDDED NEVADA'S CLAIM THAT SECRETARY WATKINS' DECISION TO PROCEED WITH THE SITE CHARACTERIZATION OF YUCCA MOUNTAIN WAS UNCONSTITUTIONAL. FURTHERMORE, THE COURT FOUND THAT NEVADA WAS PREMATURE IN EXERCISING ITS VETO POWER. BUT THE LEGAL FIGHT IS FAR FROM OVER. THERE IS NO DOUBT THAT NEVADA WILL APPEAL THIS DECISION AND ATTEMPT TO MAINTAIN THE DISTRICT COURT STAY ORDER AGAINST DOE IMPLEMENTATION OF ITS PLAN PENDING SUPREME COURT DISPOSITION OF THE CASE.

WHAT ABOUT THE POLITICAL DIMENSION? THE NINTH CIRCUIT DECISION NOTWITHSTANDING, I CAN'T IMAGINE THAT THERE WILL EVER BE A USABLE YUCCA MOUNTAIN REPOSITORY IF THE PEOPLE OF NEVADA DON'T WANT IT. THE POLITICAL BARRIER IS A DEAL BREAKER. THERE ARE JUST TOO MANY WAYS TO DELAY THE PROGRAM, EVEN IF THE SITE CHARACTERIZATION PROCEEDS.

WILL THE PEOPLE OF NEVADA ACCEPT A HIGH LEVEL WASTE REPOSITORY IN YUCCA MOUNTAIN OR ANYWHERE ELSE? REGRETTABLY, MY CONCLUSION IS THAT THEY WILL NOT. A RECENT POLL COMMISSIONED BY

THE "LAS VEGAS REVIEW JOURNAL" FOUND THAT 78% OF NEVADANS OPPOSE THE SITING OF ANY SUCH REPOSITORY ANYWHERE IN NEVADA. IN ADDITION, 80% WANT STATE LEADERS TO OPPOSE SUCH SITING WITH ANY MEANS AVAILABLE. CALL OUT THE NATIONAL GUARD.

MY ROUGH ESTIMATE IS THAT IF NEVADA EXHAUSTS ALL OF ITS OPTIONS AND WAGES TOTAL POLITICAL AND REGULATORY WAR OVER YUCCA MOUNTAIN, IT WOULD BE AT LEAST ANOTHER TWENTY YEARS BEFORE ALL THE OTHER STATES COULD GANG UP ON NEVADA AND FORCE THIS SITE DOWN THEIR THROATS. THIS MIGHT NOT HAVE BEEN THE CASE IF AN EASTERN SITE HAD BEEN SIMULTANEOUSLY DESIGNATED WITH YUCCA MOUNTAIN, BUT THAT WOULD HAVE IGNITED ITS OWN POLITICAL MAELSTROM - THE PROVERBIAL CATCH-22.

CAN A SAFE REPOSITORY BE BUILT AND LICENSED AT YUCCA MOUNTAIN WITHIN A REASONABLE SPAN OF TIME? THE ISSUE OF SAFETY IS WHAT THE CHARACTERIZATION IS ALL ABOUT. LAST YEAR THE NATIONAL RESEARCH COUNCIL'S BOARD ON RADIOACTIVE WASTE MANAGEMENT ISSUED ITS REPORT: "RETHINKING HIGH-LEVEL RADIOACTIVE WASTE DISPOSAL." IN THE BODY OF THAT REPORT THE BOARD CONCLUDES THAT: "THERE IS NO SCIENTIFIC REASON TO THINK THAT AN ACCEPTABLE HLW REPOSITORY CANNOT BE BUILT AND LICENSED." CASE CLOSED? NOT QUITE.

THE NAS/NRC REPORT GOES ON TO CONCLUDE THAT "THE U.S. PROGRAM, AS CONCEIVED AND IMPLEMENTED OVER THE PAST DECADE IS UNLIKELY TO SUCCEED." IN OTHER WORDS, SCIENCE DOES NOT RULE OUT THE POSSIBILITY OF SITING AND CONSTRUCTING A SAFE REPOSITORY, BUT WE WON'T GET THERE THE WAY DOE HAS CHOSEN TO DO THE JOB. A

PRINCIPLE REASON FOR THIS IS THE U.S. HAVING ADOPTED A WASTE DISPOSAL PROGRAM THAT "IS CHARACTERIZED BY A HIGH DEGREE OF INFLEXIBILITY WITH RESPECT TO BOTH SCHEDULE AND TECHNICAL SPECIFICATIONS."

LET'S TAKE THIS A STEP FURTHER. EVEN IF ALL THAT WE HAVE REVIEWED SO FAR IS WRONG, IS IT PRUDENT TO BELIEVE THAT THE DOE CAN MANAGE A YUCCA MOUNTAIN ONCE IT IS BUILT? GIVEN THE LEGACY OF HANFORD, FERNALD, WEST VALLEY, SAVANNAH RIVER ETC., THE ANSWER TO THAT QUESTION MUST BE - NO. I KNOW THAT UNDER ADMIRAL WATKINS' LEADERSHIP THERE IS A HIGH LEVEL COMMITMENT TO REVERSE THIS DISMAL RECORD. BUT WE ARE NOT THERE YET. WE CANNOT BASE OUR PLANS ON PROMISES, ONLY ON PAST PERFORMANCE.

TIME IS RUNNING OUT. MUCH OF WHAT I HAVE READ AND HEARD FROM THE INDUSTRY, DOE AND EVEN MY FELLOW REGULATORS SOUNDS PAINFULLY LIKE WHISTLING PAST THE GRAVEYARD. A PERMANENT DISPOSAL SITE WON'T HAPPEN BECAUSE WE WANT IT TO, OR BECAUSE WE HOPE IT WILL AND MAYBE NOT EVEN IF WELL MEANING AND ABLE MANAGERS MAKE EVERY EFFORT FOR IT TO HAPPEN. AT SOME POINT - AND I WOULD POSIT THAT THAT TIME IS SOONER RATHER THAN LATER - WE MUST DECIDE THAT WE JUST AREN'T GOING TO MAKE IT. THEN WHAT?

THE OPTIONS FACING US ARE NOT PRETTY. THE UNDERLYING PREMISE BEHIND ANY CONSIDERATION OF OPTIONS IS THAT THE CURRENT PLAN FOR PERMANENT DISPOSAL IN GENERAL, AND THE SPECIFIC USE OF YUCCA MOUNTAIN, JUST WON'T WORK. GIVEN THAT ASSUMPTION, AND I AM PREPARED TO ADVANCE IT AS THE ONLY REALISTIC CONCLUSION TO DRAW, THERE ARE FIVE OPTIONS AVAILABLE TO US.

WE CAN: 1) CONTINUE ALONG THE PATH WE ARE NOW FOLLOWING KNOWING THAT IT WON'T WORK BUT BELIEVING THAT FOR APPEARANCES' SAKE WE OUGHT TO SPEND THE BILLIONS ON A DOOMED EFFORT IN THE HOPE THAT WE ARE BUYING TIME; 2) ADOPT A PERMANENT ON-SITE STORAGE APPROACH; 3) DEPLOY THE MONITORED RETRIEVABLE STORAGE PROGRAM; 4) REVISIT FUEL REPROCESSING; OR 5) DELAY THE SITING OF THE PERMANENT REPOSITORY FOR SEVERAL DECADES AND STORE ON-SITE IN THE INTERIM.

OPTION ONE - THE OSTRICH APPROACH - IS ATTRACTIVE BUT UNCONSCIONABLE. IF THE GIG IS UP, WE HAVE TO ADMIT IT. THE REASON IS SIMPLE. WITHOUT SUCH AN ADMISSION WE WILL LOSE CRITICAL TIME TO DEVELOP AN ALTERNATIVE.

WHAT ABOUT OPTION TWO - PERMANENT ON-SITE STORAGE? THIS TOO IS UNACCEPTABLE. OPTION TWO IS EXPEDIENT IN THE SHORT TERM BUT GROSSLY IRRESPONSIBLE IF I REMEMBER ANY OF MY SOPHOMORE PHYSICS. AS MANY HAVE POINTED OUT, AS BAD AS A PERMANENT, POORLY SITED UNDERGROUND REPOSITORY MIGHT BE, IT IS INFINITELY SAFER THAN A PROGRAM OF PERMANENT STORAGE ABOVE GROUND IN DRY CASKS OR IN FUEL POOLS. UNFORTUNATELY OPTION TWO DOES NOT CONSTITUTE A FIX OF THE NUCLEAR WASTE CRISIS AND WILL EFFECTIVELY TERMINATE ANY FUTURE EXPANSION OF THE U.S. NUCLEAR POWER OPTION. WITH GLOBAL WARMING AND ACID RAIN WE CANNOT ACCEPT THIS RESULT.

WHAT ABOUT THE MRS - OPTION THREE? THE WASTE ACT CALLS FOR THE SITING OF AN ABOVE GROUND MONITORED RETRIEVABLE STORAGE PROGRAM. THIS SUPPOSEDLY WOULD OFFER AN INTERIM SOLUTION TO DELAYS IN THE GEOLOGICAL PERMANENT REPOSITORY. HOWEVER, CONGRESS

COUPLED THE MRS WITH THE PERMANENT REPOSITORY PRECISELY BECAUSE IT THOUGHT, AND RIGHTLY SO, THAT NO STATE WOULD ACCEPT AN MRS UNLESS A PERMANENT REPOSITORY HAD BEEN LICENSED FOR FEAR THAT THE MRS WOULD BECOME THE PERMANENT SITE.

DECOUPLING THE MRS FROM THE PERMANENT REPOSITORY WON'T WORK. CONGRESS WILL NOT LIKELY DO IT, AND IF CONGRESS DID SO, NO STATE WOULD ACCEPT IT. IF CONGRESS OR DOE TRIED TO FORCE AN MRS ON A STATE, WE WOULD HAVE YUCCA MOUNTAIN ALL OVER AGAIN AND WE WOULD BE BACK TO SQUARE ONE. AS THE RED QUEEN SAID TO ALICE: "IT TAKES ALL THE RUNNING YOU CAN DO TO KEEP IN THE SAME PLACE."

IF WE CANNOT BUILD PYRAMIDS UNDERGROUND, PERHAPS WE COULD SCALE THE PROBLEM DOWN TO SIZE AND THAT MIGHT MEAN RECYCLING AND REPROCESSING SPENT FUEL - OPTION FOUR. THE EUROPEANS AND JAPANESE HAVE BOTH RECOGNIZED THIS REALITY OF THE EQUATION FOR WASTE RELIEF. CALL IT A "BOTTLE BILL" FOR NUCLEAR POWER.

NOW, I SAID THE ALTERNATIVES TO PERMANENT STORAGE OF SPENT FUEL ARE UGLY. ESTABLISHING A CREDIBLE NUCLEAR FUEL REPROCESSING PROGRAM FOR THE AMERICAN NUCLEAR INDUSTRY ON THE SCALE REQUIRED WOULD BE <u>REALLY</u> UGLY. ANY SUCH SYSTEM OF FACILITIES WOULD VASTLY MULTIPLY THE PHYSICAL SECURITY PROBLEM OF THE CURRENT PLAN. WITH SADDAM HUSSEIN LURKING ON THE HORIZON, CAN ANYONE ARGUE THAT THE NUCLEAR PROLIFERATION ISSUE IS ANY LESS OMINOUS NOW THAN IT WAS IN 1977 WHEN WE ABANDONED THE REPROCESSING OPTION?

IN ADDITION, THE RESIDUE FROM SUCH PLANTS WOULD ALSO REQUIRE PERMANENT DISPOSAL ALBEIT AT A GREATLY REDUCED SCALE. THE ECONOMICS OF YELLOW CAKE NOW SEEM TO MAKE REPROCESSING THE

UNECONOMICAL CHOICE. BUT DOES SUCH AN ANALYSIS FACTOR IN THE $40 BILLION ANTICIPATED COST OF THE CURRENT PLAN?

REPROCESSING IS NO EASY OPTION. TO DEVELOP A CREDIBLE REPROCESSING OPTION WOULD TAKE TIME, AND TO IMPLEMENT IT WOULD TAKE EVEN MORE TIME. AND TIME IS WHAT WE THINK WE DON'T HAVE. THE BIGGEST OBSTACLE TO OVERCOME FOR A REPROCESSING OPTION WOULD BE, IN MY OPINION, THE QUESTION OF THE MANAGEMENT OF THE PROGRAM. THE LOGICAL CHOICE FOR THIS ASSIGNMENT WOULD BE THE DOE, BUT THE LITANY OF DOE MANAGEMENT DISASTERS AT EXISTING NUCLEAR MATERIAL PROCESSING PLANTS DOES NOT RECOMMEND THIS AGENCY FOR THIS ROLE. AGAIN, I DIDN'T SAY THERE ARE ANY EASY CHOICES HERE. THAT'S WHY WE ARE PAID THE BIG BUCKS.

NOW WE COME TO THE FINAL OPTION: DELAY THE SITING OF THE PERMANENT REPOSITORY FOR SEVERAL DECADES AND STORE ON-SITE IN THE INTERIM. WHAT WOULD THIS OPTION ENTAIL? AS FAR AS I CAN DETERMINE, OPTION FIVE MUST INCLUDE AT LEAST FOUR ELEMENTS. FIRST, IT WOULD NECESSITATE THE ABANDONMENT OF THE YUCCA MOUNTAIN SITE OR AT LEAST THE SCALING BACK OF THE CHARACTERIZATION EFFORT FOR YUCCA TO PUT IT IN THE CONTEXT OF OTHER POTENTIAL SITES. IT WOULD MOST CERTAINLY REQUIRE THAT CONGRESS AND THE DOE LIFT THE DESIGNATION YOKE FROM YUCCA'S THROAT.

SECOND, OPTION FIVE WOULD REQUIRE THAT THE LEAD FEDERAL AGENCY CHARGED WITH THE HIGH LEVEL WASTE PROGRAM LAUNCH A THOROUGH NATIONAL EVALUATION OF POTENTIAL GEOLOGICAL SITES WITH THE OBJECTIVE OF DEVELOPING A LIST OF ACCEPTABLE SITES WITHIN THE NEXT THREE DECADES. I LEFT THE IDENTITY OF THE DESIGNATED AGENCY

DELIBERATELY BLANK BECAUSE IT IS NOT SELF-EVIDENT TO ME THAT DOE SHOULD AUTOMATICALLY BE THAT AGENCY. MAYBE IT SHOULD BE THE USGS.

WE NEED TO ACKNOWLEDGE THAT THE TIME OF DRACONIAN SITING APPROACHES WHICH FORCE STATES AND COMMUNITIES TO ACCEPT WASTE FACILITIES IS PROBABLY OVER (IF IT EVER REALLY EXISTED). THERE NEEDS TO BE AN UP FRONT COMMITMENT TO VOLUNTARISM IN THE SITING OF THE REPOSITORY. THAT MEANS GIVING STATES AND LOCAL GOVERNMENTS FULL PARTICIPATION RIGHTS IN THE PROCESS AS WELL AS AFFORDING LOCAL CONTROL IN IMPORTANT DECISIONS. THIS APPROACH IS BEING TRIED RIGHT NOW, WITH SOME SUCCESS, IN CANADA WITH RESPECT TO LOW-LEVEL WASTE SITES, AND IT HAS PROMISE FOR AFFORDING NEW, INNOVATIVE AND POTENTIALLY WORKABLE APPROACHES FOR THE HIGH-LEVEL WASTE DISPOSAL MORASS IN THIS COUNTRY.

IT IS ALSO NOT SELF-EVIDENT THAT WE SHOULD CONFINE THIS SEARCH TO U.S. BOUNDARIES. AS SUGGESTED BY WOLF HAFELE IN A RECENT "SCIENTIFIC AMERICAN" ARTICLE, THIS EFFORT MIGHT BE BEST ACCOMPLISHED IN AN INTERNATIONAL CONTEXT BECAUSE THE HIGH LEVEL WASTE PROGRAM IS INTERNATIONAL BY ITS VERY NATURE. ALL NUCLEAR POWER NATIONS HAVE A STAKE IN SOLVING THIS PROBLEM, AND SOLUTIONS LIKE MID-OCEAN ISLAND STORAGE WOULD BECOME MORE LIKELY IF ADOPTED BY AN INTERNATIONAL PROCESS.

THE THIRD ELEMENT OF OPTION FIVE WOULD BE THE IMPLEMENTATION OF A PLAN OF ON-SITE STORAGE OF SPENT FUEL FOR THE NEXT 100 YEARS. KARL COHEN, FORMERLY OF G.E., HAS ADVANCED THIS INTERMEDIATE SOLUTION. WE HAVE THE TECHNOLOGY TO ACCOMPLISH THIS

ALREADY AT HAND. THE NRC HAS CERTIFIED DRY CASK STORAGE AS SAFE AS GEOLOGICAL STORAGE FOR BETWEEN 120 AND 150 YEARS. PERHAPS CONCRETE CANISTERS WOULD MEET THE SAME STANDARDS.

THE FOURTH ELEMENT OF OPTION FIVE WOULD BE THE LAUNCHING OF A SERIOUS RE-EXAMINATION OF THE FUEL REPROCESSING OPTION. IF IT WERE POSSIBLE TO NEGOTIATE THE HURDLES TO THIS OPTION THAT I HAVE ALREADY ENUMERATED, IT WOULD REDUCE OUR HIGH LEVEL WASTE DISPOSAL PROBLEM BY ROUGHLY A FACTOR OF FIVE. WE MUST REMEMBER THAT ALL THIS SOUND AND FURY ABOUT YUCCA MOUNTAIN IS ONLY OVER THE <u>FIRST</u> REPOSITORY SITING. IF WE CONTINUE WITH NUCLEAR POWER, WE WILL NEED TO SITE MANY MORE.

OPTION FIVE HAS ITS OBVIOUS DRAWBACKS. UNLESS LAUNCHED WITH A CLEAR MANDATE AND COMMITMENT, IT CARRIES WITH IT ALL THE NEGATIVE BAGGAGE OF A PURE OPTION TWO SOLUTION: NAMELY, IT BRINGS TO A HALT NUCLEAR POWER IN THE U.S. BECAUSE ON-SITE STORAGE IS CLEARLY NOT A PERMANENT SOLUTION. FURTHERMORE, FROM THE UTILITY REGULATOR'S POINT OF VIEW IT GUARANTEES THAT OUR RATEPAYERS WILL HAVE TO PAY TWICE FOR SPENT FUEL STORAGE. FINALLY, FROM THE INDUSTRY'S POINT VIEW AND PERHAPS EVEN FROM THE VIEWPOINT OF WASHINGTON POLICY MAKERS, OPTION FIVE COULD BE CONSTRUED AS GOING BACKWARD IN TIME TO A PRE-1987 OR EVEN 1982 STATUS. ALICE, WHERE ARE YOU WHEN WE NEED YOU?

I RECOGNIZE ALL OF THESE DRAWBACKS WITH THIS PROPOSAL, BUT I DON'T BELIEVE THE OTHER OPTIONS ARE VIABLE. WE MOST CERTAINLY CANNOT PLUNGE AHEAD IN PURSUIT OF A MIRAGE-LIKE PERMANENT REPOSITORY AT YUCCA MOUNTAIN. LET'S FACE THE TRUTH. IT AIN'T

GOING TO HAPPEN.

NOW, AS FOR THE OTHER TOPIC OF THIS PANEL, I HAVE VERY LITTLE TO SAY. IT IS UNDOUBTEDLY A GOOD AND PROPER THING THAT VARIOUS VENDORS ARE WORKING HARD TO DEVELOP AN INHERENTLY SAFER NUCLEAR GENERATING SYSTEM. TO YOU I CAN ONLY SAY: GOOD LUCK. NO, I HAVE A LITTLE MORE THAN THAT TO SAY.

IN MY OPINION, THE CHALLENGE YOU HAVE UNDERTAKEN MUST TAKE INTO ACCOUNT TWO SPHERES OF REALITY: THE SAFETY ISSUE AS IT ANIMATES PUBLIC OPINION ABOUT NUCLEAR POWER AND THE ECONOMICS OF POWER GENERATION IN THIS LAST DECADE OF THE CENTURY. IF YOU SATISFY THE ONE SPHERE OF REALITY WITHOUT THE OTHER, YOU WILL MOST CERTAINLY FAIL.

IN TERMS OF THE SAFETY SPHERE OF REALITY, I WILL ONLY OFFER A COUPLE OF OBSERVATIONS. CREDIBILITY WILL BE EVERYTHING IN THIS GAME. BE MODEST. DON'T OVERSELL YOUR PRODUCT. IF YOUR EMERGENCY WATER INJECTION SYSTEMS RELY ON SENSOR ACTIVATION, YOU DON'T HAVE A PASSIVELY SAFE SYSTEM. IF YOUR PHYSICAL ACTIVATION SYSTEM FOR ANY BACKUP WATER INJECTION CAN BE SET FOR DIFFERENT PRESSURE SETTINGS CAREFULLY EXPLAIN THAT THIS IS A CRUCIAL JUDGMENT CALL THAT MUST BE MADE BY INSTITUTIONS THAT HAVE LITTLE OR NO CREDIBILITY. AND IF YOUR CONTROL AND SAFETY RODS STILL MUST DEFY GRAVITY TO OPERATE, TRY ANOTHER DESIGN. BY THE WAY, I PERSONALLY BELIEVE THAT ALL OF THESE HURDLES CAN BE OVERCOME.

HERE I SPEAK ONLY TO THE LIGHT WATER DESIGNS UNDER DEVELOPMENT. AS FOR THE MORE EXOTIC ADVANCED REACTORS, I WILL ONLY OBSERVE THAT IF YOU MUST ELIMINATE CONTAINMENT TO MAKE THE NUMBERS WORK, FORGET IT. PEOPLE DIED AT CHERNOBYL AND NOBODY DIED AT TMI. THE DIFFERENCE WAS CONTAINMENT, AND I WILL STATE CATEGORICALLY THAT NO NUCLEAR POWER STATION WILL EVER BE BUILT IN THIS COUNTRY WITHOUT A CONTAINMENT STRUCTURE.

AS FOR THE ECONOMIC SPHERE, NUCLEAR POWER STATIONS WILL NOT BE ORDERED UNLESS THEY CAN BEAT THE ECONOMIC BOGEYMAN. DON'T EXPECT ANY SPECIAL TREATMENT FROM REGULATORS BECAUSE THIS IS CLEAN NUCLEAR POWER - THAT IS, UNLESS YOU CAN COME UP WITH SOME PLAN TO MAGICALLY TRANSFORM THE COSTS OF THE "EXTERNALITIES" INTO MONEY IN RATEPAYERS' POCKETS.

ONE OF THE BIGGEST ECONOMIC HURDLES IS THE EXCESS CAPACITY DISALLOWANCE. GIVEN THE RECENT HISTORY AND CURRENT FORECASTS OF LOAD GROWTH, IT WILL BE VERY DIFFICULT TO EVEN ADD 600MW CHUNKS OF CAPACITY TO OUR SYSTEMS WITHOUT TRIGGERING EXCESS CAPACITY PENALTIES. THE ECONOMICS OF THE PLANT MUST TAKE THIS EVENTUALITY INTO ACCOUNT.

ANOTHER MAJOR HURDLE WILL BE THE LEAST COST PROCUREMENT TEST. EACH NEW UNIT MUST BE ABLE TO COMPETE WITH OTHER SOURCES OF POWER ON A LEAST COST BASIS AT THE TIME OF SELECTION OF THE UNIT, AND THE UNIT WILL BE HELD ACCOUNTABLE FOR ANY ESCALATION IN COST. THE LEAST COST TEST IS BECOMING A SIGNIFICANT EARLY HURDLE FOR ANY GENERATING UNIT TO CLEAR. UP FRONT HEARINGS ON THE INCORPORATION OF A UNIT INTO A PRODUCTION PLAN PLACES GREATER

RISK AT THE DEVELOPMENTAL PHASE BUT CAN REINFORCE THE SELECTION DURING ITS CONSTRUCTION.

I WAS PLEASED TO HEAR AN ESTIMATE OF THE AP600 AT UNDER $1300/KW AT THE RECENT SUMMER MEETINGS OF NARUC. BUT A GAS-FIRED COMBINED CYCLE UNIT IS $800/KW AND CAN BE BUILT ON A SCHEDULE WITH MORE FLEXIBILITY TO MEET EXPECTED LOAD GROWTH. WAKE UP PEOPLE! UNTIL YOU CAN MATCH THAT PERFORMANCE, YOU WON'T SELL A SINGLE UNIT IN THE U.S.

FINALLY, A THIRD ECONOMIC HURDLE IS THE RESTRUCTURING OF THE GENERATION SIDE OF THE ELECTRIC BUSINESS. CAN YOU BID THE OPPORTUNITY TO PROVIDE POWER FOR A FIXED PRICE WITHIN A KNOWN TIME HORIZON? I BELIEVE THE ONLY WAY WESTINGHOUSE OR GE WILL GET AN AP600 OR AN SBWR TO THE MARKET IS NOT TO BE AN EQUIPMENT SUPPLIER BUT TO BE AN ELECTRICITY SUPPLIER. THEY WOULD BE NUCLEAR IPP'S BIDDING TO PROVIDE ENERGY AT SUCH AND SUCH A PRICE, AT SUCH AND SUCH A FUTURE DATE, JUST AS B & W, WHEELABRATOR, AES, BECHTEL, AIR PRODUCTS, BONNEVILLE PACIFIC, O'BRIEN ENERGY, LONG LAKE ENERGY AND PYROPOWER ALL ARE DOING TODAY.

THERE IS VERY LITTLE YOU CAN DO TO MAKE THE FUTURE NUCLEAR TECHNOLOGY MORE ATTRACTIVE UNTIL YOU COME TO GRIPS WITH THE INDUSTRY RESTRUCTURING WHICH IS PLACING THE RISKS OF POWER DEVELOPMENT ON INDEPENDENT ENTREPRENEURS. THESE INDEPENDENTS WILL BE LESS LIKELY TO TAKE A RISK ON NUCLEAR TECHNOLOGY WHEN THEY CAN AVOID THE HAZARDS OF THE INDUSTRY WITH VIRTUALLY ANY OTHER TECHNOLOGY ON THE MARKET AND BEAT NUCLEAR'S PRICE.

IN CONCLUSION, I BELIEVE THERE IS STILL TIME TO REJUVENATE THE NUCLEAR POWER INDUSTRY IN THE U.S. TO DO SO, HOWEVER, WILL REQUIRE NEW THINKING AND A WILLINGNESS TO HEAR WHAT IS SAID, NOT WHAT WE WANT TO HEAR. AND NOW I'D LIKE TO FOLLOW THE ADMONITION OF THE KING TO THE WHITE RABBIT WHEN HE SAID "BEGIN AT THE BEGINNING, AND GO ON TILL YOU COME TO THE END: THEN STOP." THANK YOU.

file - MRS

The Secretary of Energy
Washington, DC 20585

June 27, 1991

The Honorable Albert Gore, Jr.
United States Senate
Washington, D.C. 20510

Dear Senator Gore:

As part of the legislative proposal to implement the National Energy Strategy, the Administration submitted to the Congress provisions which would enable the Department of Energy (DOE) to carry out, in a timely and participatory manner, its statutory mandate to determine the suitability of the Yucca Mountain, Nevada, candidate repository site. As you may know, in 1987 the Congress passed the Nuclear Waste Policy Act Amendments which directed the Department to scientifically determine the suitability of this site as a long-term repository for high-level radioactive waste.

Since the 1987 Amendments were passed, we have continually tried to implement the mandate of Congress and conduct the scientific investigations necessary to determine whether the site is suitable. In addition, we have made every effort to work cooperatively with the State of Nevada, whose repeated avowed intention, as expressed both in the courts and in the press, has been to "exercise every power and every aspect of its inherent jurisdiction to frustrate the Federal program." As late as March of this year, Nevada Governor Miller stated to a U.S. Senate committee that the State of Nevada would continue to block the necessary scientific study of the Yucca Mountain site.

Recently, the Senate Committee on Energy and Natural Resources, by a vote of 14-5, favorably reported S. 1138, a bill which would permit the Department to proceed with site characterization work. Shortly after this action, Governor Miller wrote to all governors opposing this legislation. I thought it was important to share with you my response to Governor Miller, provide you with the background that led to the need to seek a legislative remedy, and the specific nature of the proposed legislation. I have written your Governor as well, and have enclosed a copy of that letter.

Effective management of high-level nuclear waste is one of the primary environmental and energy resource issues facing this Nation. It is a matter of national concern requiring a national solution, particularly as we strive to achieve a comprehensive, balanced energy strategy that assures adequate energy supplies while protecting our environment. With nuclear power providing 20 percent of the electricity to meet this country's energy needs, we must be concerned about the long-term impact of delays in the nuclear waste disposal program.

You probably know the history of the high-level radioactive waste program. Its objective is a scientifically sound and responsible means to remove spent nuclear fuel and high-level waste from many locations throughout the Nation and to dispose of those materials in an engineered geologic repository. At this time, there are approximately 20,000 metric tons of spent fuel being stored at over 75 separate locations around the country. By 2010, when the repository is scheduled to be operational, there will be 58,600 metric tons of spent fuel in temporary storage.

The Department is required by law to study only one site -- Yucca Mountain, Nevada -- to determine whether that site is suitable for the location of a deep geologic repository for commercial nuclear waste. By law, we have no alternative.

The State had consistently refused to issue, or even to process, environmental permits required for DOE to begin new surface-disturbing activities on the Yucca Mountain site, so we challenged the State in court. The courts have repeatedly upheld the DOE in these cases. In spite of the fact that the State very recently issued one permit and announced the intention to issue a second permit as a result of the court decisions, I have no reason to believe that the State has any intention of wavering from its clearly enunciated commitment to obstruct and delay this program at every opportunity.

I should emphasize the narrowness of the alteration of Nevada's authorities under Federal law that this legislation would address. The legislation would leave intact the State of Nevada's authority under the Nuclear Waste Policy Act to veto any future decision to select Yucca Mountain as the site for the repository. Even the suspension of the State's permitting authority under the environmental laws contained in this legislation would apply <u>only</u> to the narrow task of determining the site's scientific suitability as a repository.

Contrary to the statements contained in Governor Miller's letter, this legislation would not make the Department of Energy "self-regulated." DOE would remain fully regulated by the Environmental Protection Agency under the environmental laws, and still would have to demonstrate compliance with those laws in order to obtain permits under them. Nor would there be any precedent about States' rights set by this legislation. It has been clear since 1819 that States may not impede or regulate national activities like this one without the explicit approval by the Congress. The Congress has given that approval for State regulation of Federal activities in the environmental laws. The only precedent involved here is the State of Nevada's exploitation of this grant of power under these laws to frustrate a national program required by national law, instead of the impartial administration of the environmental laws that Congress had anticipated and that DOE had every right to expect.

In enacting the Nuclear Waste Policy Act, the Congress recognized that the disposal of high-level radioactive waste is a national issue requiring a national solution. I do not like having to pursue legislation to temporarily suspend a State's regulatory authority. I would much rather work on these issues in a cooperative manner. But I believe that you would agree that use of the environmental permitting process to thwart the will of Congress in bringing resolution to the serious question of permanent high-level waste management is inappropriate. In this light, I ask that you carefully consider the issues raised in my letters, and support S. 1138.

Sincerely,

James D. Watkins
Admiral, U.S. Navy (Retired)

Enclosure

The Secretary of Energy
Washington, DC 20585

June 24, 1991

The Honorable Ned Ray McWherter
Governor of Tennessee
Nashville, Tennessee 37243-0001

Dear Governor McWherter:

You recently received a letter from Nevada Governor Bob Miller asking your support in opposing legislation currently before the Congress to enable the Department of Energy to carry out, in a timely and participatory manner, its statutory mandate to determine the suitability of the Yucca Mountain candidate repository site. In his letter, Governor Miller asserts that this legislation is a threat to all States' rights. I disagree, and I hope you will consider the background that led to the need to seek a legislative remedy and the specific nature of the proposed legislation before you act on Governor Miller's request.

Effective management of high-level nuclear waste is one of the primary environmental and energy resource issues facing this Nation. It is a matter of national concern requiring a national solution, particularly as we strive to achieve a comprehensive, balanced energy strategy that assures adequate energy supplies while protecting our environment. With nuclear power providing 20 percent of the electricity to meet this country's energy needs, we must be concerned about the long-term impact of delays in the nuclear waste disposal program.

You probably know the history of the high-level radioactive waste program. Its objective is a scientifically sound and responsible means to remove spent nuclear fuel and high-level waste from many locations throughout the Nation and to dispose of those materials in an engineered geologic repository. At this time, there are approximately 20,000 metric tons of spent fuel being stored at over 75 separate locations around the country. By 2010, when the repository is scheduled to be operational, there will be 58,600 metric tons of spent fuel in temporary storage.

DOE is required by law to study only one site -- Yucca Mountain, Nevada -- to determine whether that site is suitable for the location of a deep geologic repository for commercial nuclear waste. By law, we have no alternative.

Since the 1987 Amendments to the Nuclear Waste Policy Act were passed, we have continually tried to implement the mandate of Congress and conduct the scientific investigations necessary to determine whether the site is suitable. In addition, we have made every effort to work cooperatively with the State of Nevada, whose repeated avowed intention, as expressed both in the courts and in the press, has been to "exercise every power and every aspect of its inherent jurisdiction to frustrate the Federal program." As late as March of this year, Governor Miller stated to the U.S. Senate Energy and Natural Resources Committee that the State of Nevada would continue to block the necessary scientific study of the Yucca Mountain site.

The State refused to issue, or even to process, environmental permits required for DOE to begin new surface-disturbing activities on the Yucca Mountain site, so we challenged the State in court. The courts have repeatedly upheld the DOE in these cases. In spite of the fact that the State very recently issued one permit and announced the intention to issue a second permit as a result of the court decisions, I have no reason to believe that the State has any intention of wavering from its clearly enunciated commitment to obstruct and delay this program at every opportunity.

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Sincerely,

James D. Watkins
Admiral, U.S. Navy (Retired)