A PROPOSED ALTERNATIVE STRATEGY FOR THE DEPARTMENT OF ENERGY'S CIVILIAN RADIOACTIVE WASTE MANAGEMENT PROGRAM

Prepared by the Task Force
on an Alternative Program Strategy

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TASK FORCE ON AN ALTERNATIVE PROGRAM STRATEGY

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TABLE OF CONTENTS

March 31, 1993

A Proposed Alternative Strategy For The DOE Civilian Radioactive Waste Management Program

I. FOREWORD

In developing this strategy for outside review, the Task Force has sought, first, to define in clear and simple terms the program mission and objectives the strategy seeks to achieve. In our judgment, many of the problems the program has encountered stem, in no small part, from the fact that, over time, the program's participants and its external stakeholders have held confused and even conflicting notions about the program's goals and objectives. No program strategy is likely to succeed that does not flow from a clear and common vision among its participants and stakeholders of precisely what the program is trying to do, and why.

For that reason also, the Task Force believes that any successful program strategy must address the key concerns of the program's diverse stakeholders. The Department of Energy has discussed many elements of the alternative strategy described in this report with stakeholders in a variety of forums over recent years. We call for an intensive process of interaction with those stakeholders to ensure that any strategy eventually adopted comes as close as possible to embodying a stakeholder consensus.

We have also tried to develop a strategy that requires little or no change in the law or regulations beyond any already underway. We believe the current legal and regulatory framework allows ample room for pursuing an alternative strategy that can better achieve the program's mission and objectives, and meet the concerns of its stakeholders.

II. SUMMARY

The Problem with the Current Strategy

Background

The Nuclear Waste Policy Act of 1982 (NWPA) directed the Department of Energy to lead the nation's effort to create a system for the safe and final disposal of highly radioactive wastes in one or more deep geologic repositories. The central issue the Act resolved was whether the best way to protect human and environmental health and safety was to develop a system for permanent disposal of those wastes or to store them for long periods of time before deciding on disposal. Congress decided that the generation which first enjoyed the benefits of nuclear energy had an obligation to give future generations a clear option for disposal and to bear the political and financial costs of developing that option.

To meet that obligation, NWPA set an ambitious schedule for DOE to site two geologic repositories and to begin disposal in the first by January 31, 1998. In 1987 amendments, Congress directed the Department to study only one site at Yucca Mountain, Nevada to decide whether it is suitable for a repository.

NWPA required utilities with nuclear power plants to pay a fee to fund the disposal program. In return, the Federal government would accept their spent (used) reactor fuel for disposal. (As allowed by the Act, DOE will also accept waste from defense nuclear activities for disposal.) The expectation was that acceptance would begin in 1998 at the first repository, and that waste would be emplaced in the repository as soon as it was accepted. That would avoid the need for substantial surface storage for extended periods at reactors or Federal storage facilities.

The law required the Environmental Protection Agency (EPA) to set safety standards for disposal, and the Nuclear Regulatory Agency (NRC) to issue regulations to enforce those standards. Because of concerns about the workability of the unprecedented standards and regulations that were issued, Congress in 1992 directed the National Academy of Sciences (NAS) to study the issues and make scientific findings and recommendations. EPA is to issue a new safety standard for the Yucca Mountain site that conforms to these recommendations, and NRC is to revise its regulations accordingly.

The Current Strategy

Over the decade since NWPA, the disposal program's strategy, based on its interpretation of the legislative mandate and regulatory requirements, has sought:

- in a single large step and under a tight schedule, to achieve the first-of-a-kind licensing of a first-of-a-kind repository for isolating wastes from the human environment for many thousands of years.

- in a single large step and as rapidly as possible, to build a full-scale repository and begin disposing of the bulk of the nation's inventory of spent fuel and high-level radioactive waste.

The goal of that strategy is rapid, full-scale disposal. The strategy assumed that we owed the future no less than the rapid, full and final disposal of waste. A broad range of stakeholders did, in fact, share that assumption when NWPA was passed.

The Problem

The technical and institutional optimism underlying the ambitious schedules in the NWPA has not been borne out. The target date to start operating the first repository has slipped from 1998 to 2003 to 2010, and may slip even further. As a result, a repository can no longer serve as the basis for accepting spent fuel from utilities on a dependable schedule.

As schedules have slipped, the estimated costs of studying a site to determine its suitability for a repository and prepare a license application have risen from $100 million in 1982 to $6.3 billion now. Current plans call for spending at least $6.3 billion and waiting until the year 2001 before deciding on suitability and a license application. Another $3 billion and nearly nine more years would be invested before NRC finally decides whether to allow disposal in the repository. That creates two critical problems for the program and for its various "stakeholders":

- huge investment risk on the one hand,

- and irreversible momentum on the other.

The Congress, utilities and ratepayers see high and escalating costs with no clear assurances of a favorable result in hand or in sight. The State of Nevada, some environmentalists, public interest groups and others fear that, with so much time and money invested and so much pressure for a favorable result, the program cannot afford to find the site unsuitable or unlicenseable.

In brief, the current disposal program requires a large and growing investment of time and money before the achievement, or even assurance, of any significant results to justify that investment. That is the direct result of a strategy that seeks, in single large steps, to license and operate a repository for rapid full-scale disposal.

The Alternative Strategy

The overriding purpose of the disposal program is to protect human and environmental health and safety. The alternative strategy is designed to ensure the achievement of that purpose and, in the near term, to build increasing confidence that it will be achieved. The goal of the alternative strategy is the early development and licensed demonstration of the capability for full, safe and final disposal in a repository. By "demonstrating capability," we mean to begin actual waste disposal in a licensed repository that could accommodate large amounts of waste.

The alternative strategy assumes that, while there is no urgent need for rapid full-scale disposal, we do need:

- to demonstrate as soon as possible that we have the licensed capability for disposal,

- to build increasing confidence in the near term that we will develop and demonstrate such an early capability, and

- to make provisions for meeting waste acceptance obligations in a way that does not depend on schedules for disposal in a repository.

We need that early capability to give future generations a real disposal choice. We also need that early capability -- and increasing confidence that it will occur -- to remove the greatest obstacle to providing interim storage facilities to meet the obligation to utilities: the fear that such facilities will become "de facto" repositories.

Today few, if any, stakeholders believe there is any urgent need for rapid full-scale disposal. The NRC has said that wastes can be safely stored for up to 100 years. Moreover, there is a greater sense today that,

March 31, 1993

TIMELY DISPOSAL CAPABILITY: MEETING OUR OBLIGATION TO FUTURE GENERATIONS

Underlying the NWPA is the obligation of the generation which first enjoyed the benefits of commercial nuclear power not to bequeath its hazardous wastes to future generations without also giving them the capability, should they choose to exercise it, for the safe and final disposal of those wastes. The law declared, in effect, that this generation should bear the political and financial costs of developing that option. It said that we owe future generations a clear option for safe and final disposal.

We do not know what disposal technologies may be available to succeeding generations, or what they may choose to do with the wastes that we have generated. But we do have a moral obligation to give them a real choice between safe and final geologic disposal or whatever else they may decide to do with those wastes. We should not make that choice for them. Neither should we deny them that choice. We can deny them that choice in two ways: by failing to develop a disposal capability or by irreversibly disposing of those wastes. We can ensure them that choice by demonstrating with reasonable assurance that a specific set of geologic and engineered barriers at a specific site will safely isolate those wastes for the long time periods required.

There is no urgent safety need for large-scale geologic disposal. The NRC has said that spent fuel can be safely stored at reactors or other facilities for as long as 100 years. Nor does the law call for the rapid and wholesale disposal of waste. It calls, instead, for the timely development of the capability for disposal, as it calls for the timely acceptance of waste from utilities in return for their payment of a fee to fund the program. We do need both to demonstrate as soon as possible that we have an actual site and system for safe and final disposal that is licensed by the Nuclear Regulatory Commission (NRC), and to build increasing confidence that such an early demonstration will occur. We need that early demonstration to give future generations a real disposal choice. We also need that early demonstration — and increasing confidence that it will occur — to remove the greatest obstacle to providing interim storage facilities to meet our obligation to utilities: the fear that such facilities will become *de facto* repositories.

while we owe future generations a clear option for disposal, we do not want to present them with anything irreversible or irremediable. Meeting the goal of early disposal capability would fulfill our obligation to give future generations a real disposal option without foreclosing any other options.

The alternative strategy aimed at that goal resembles the approaches taken by such countries as Sweden and Canada and recommended by the National Academy of Sciences, the Nuclear Waste Technical Review Board, and the Congressional Office of Technology Assessment.

Benefits of the Alternative Strategy

The alternative strategy seeks to build confidence that the program is on the right track by tying the increasing commitment of resources to clear results and deciding the suitability of the site, developing the repository and demonstrating its safety through a sequence of earlier, smaller, surer steps rather than a few later, larger ones.

The alternative strategy would:

- Achieve the licensed demonstration of disposal sooner and with smaller investment than the current strategy would.
- Establish clear interim milestones to mark steady progress toward the early achievement of licensed disposal capability. Such milestones reduce both investment risk and the perception of irreversible momentum by linking the increasing commitment of resources to clear progress.
- Ensure the efficient evaluation of the suitability of the Yucca Mountain site by concentrating on

those tests needed to confirm or refute a clear and robust concept of repository safety.

Key Elements of the Alternative Strategy

The Department has been exploring disposal program options, both internally and with stakeholders, since the summer of 1989. The Task Force drew upon that work in developing the alternative strategy. Thus, none of the individual elements of the alternative strategy is new. Each has been proposed in some form at one time or another by participants in the waste program or outside observers, and some are already being incorporated into the program. What is new is the integration of these elements into a coherent strategy for making steady, demonstrable progress towards the goal of licensed geologic disposal in a way that responds to the concerns that have been raised about the current strategy.

In developing this strategy, the Task Force carefully considered and explicitly rejected the option that some have proposed of putting waste in a repository before a license. (See box on page 17.)

The major elements of the alternative strategy proposed by the Task Force for discussion are:

1. The early development and broad external review of a robust repository safety concept. The program needs a clear and widely understood safety concept to guide and focus its efforts while the EPA standard and NRC regulations are under review and revision.

- Establish direct and stringent repository safety goals.
- Define that set of multiple, redundant barriers -- both natural and engineered -- that, both singly and together, are most demonstrable and offer high margins of safety.
  - Include those site features that are most important to safety and can be demonstrated at reasonable time and cost.
  - Employ a conservative engineered barrier system, including a waste package that exceeds regulatory requirements, to enhance confidence in safety.
- Submit the safety concept to broad review by the U.S. and international scientific and technical communities and key U.S. stakeholder groups, and update the concept as new data and analysis require.
- Focus site study and repository development efforts on those tests needed to confirm or refute the safety concept.

2. Periodic suitability findings during site study to lower investment risk and, if favorable, to increase confidence in the safety of the site. An ongoing external review process would be set up to help ensure the credibility of the findings.

3. Earlier formal interactions with and preliminary findings by the NRC so that increasing investments in the site can be based on increasing confidence that a repository can be licensed.

4. An early offsite waste packaging R&D facility to package small amounts of waste that can be emplaced in a repository for confirmatory testing soon after a license is received. The facility would also serve as a center for developing improved waste packages during the life of the repository.

5. Phased development of the repository after licensing so that confirmatory testing with actual waste does not have to wait until full-scale construction and operation, and so that the full-scale system can take advantage of the latest technology improvements and the results of earlier, small-scale operating experience. Key steps include:

- Start with an early licensed demonstration of small-scale disposal using a conservative system design.
- "Optimize" the repository design on the basis of the information developed during site study, licensing and small-scale operation.
- Construct and operate full-scale facilities when needed.
- Design the repository to allow an extended period of open operation and monitoring to confirm that the repository is performing as expected.

6. Clear separation of waste acceptance from emplacement in the repository for disposal. Surface storage at the repository after a disposal license is received could be used to allow adequate waste acceptance despite slower repository loading, if there is no other interim storage facility with adequate capacity.

- Multi-purpose containers – licensed by the NRC for storage, transportation and disposal – could both allow acceptance and storage with minimal surface facilities and serve as robust, retrievable disposal packages.

7. Management and institutional initiatives to ensure that the alternative strategy is carried out both efficiently and inclusively.

- Commission a thorough independent review of the program's organization and management, with particular emphasis on management of scientific investigations to ensure that they are focused on timely and efficient resolution of questions important to site suitability and disposal safety.

- Institutionalize a systematic process for interaction with the external scientific and technical community.

- Establish a Stakeholder Advisory Committee reporting to the program's director.

8. Plan for extensive public review to develop as broad a consensus as possible about any changes to the program strategy.

- Seek review of the alternative strategy by external technical and regulatory bodies: the Board of Radioactive Waste Management of the NAS, the Nuclear Waste Technical Review Board, and the NRC's Advisory Committee on Nuclear Waste.

- Contract with a recognized, independent consensus-building group to convene one or more stakeholder forums.

- Seek wide public review through a Federal Register notice and comment period

III. BACKGROUND

Program History in Brief

NWPA directed DOE to site two geologic repositories and authorized it to build the first one.

Key Features of the Act Included:

- A 1998 objective for initial operation of the first repository and a tight schedule for intermediate steps to achieve that deadline.

- A fee levied on utilities to pay for the program. In return for that fee, the Federal government was to accept fuel from utilities for disposal. The expectation was that acceptance would begin in 1998 at the first repository.

- Extensive provisions for State and public participation because that was "essential in order to promote public confidence in the safety of disposal."

- A DOE study on the need for a Monitored Retrievable Storage (MRS) facility and a DOE proposal for building one.

- Issuance by early 1984 of safety standards for disposal by the Environmental Protection Agency (EPA) and by 1984 of regulations to enforce those standards by the Nuclear Regulatory Commission (NRC).

For the first repository, DOE considered nine sites it had already identified as potential sites in six States. For the second, it did preliminary screening in 17 States. In 1986, DOE indefinitely postponed work on sites for the second repository and narrowed the search to three sites for the first repository.

The DOE MRS study concluded that such a facility was needed and DOE proposed, in 1987, to build one in Oak Ridge, Tennessee. The community of Oak Ridge favored the facility but the State opposed it.

In 1987, Congress amended NWPA (Amendments Act), directing DOE to study only one site at Yucca Mountain, Nevada for the first repository and prohibiting DOE from doing any work on a second repository. The Amendments Act also established the office of Negotiator to seek voluntary hosts for an MRS or a repository. The Act rejected the proposal to

build an MRS in Oak Ridge. It authorized DOE to build an MRS but set limits on its capacity and tied its schedule closely to that of a repository.

The State of Nevada has adamantly opposed as unfair the selection of Yucca Mountain as the only repository site to be studied.

DOE schedules for starting to operate the first repository have slipped from 1998 to 2003 to 2010. The repository can no longer serve as the basis for starting to accept waste from utilities in 1998. DOE has relied on the Negotiator to find a voluntary host for an MRS. Thus far, the Negotiator has not found a host.

Regulatory History in Brief

The NRC issued its regulations in 1983 and EPA its standard in 1985. In 1987, a U.S. Court of Appeals ordered EPA to reconsider the standard because of unexplained inconsistencies with the Safe Drinking Water Act. Because of concerns about the workability of the unprecedented standards Congress, in the Energy Policy Act of 1992, directed the NAS to study the issues and, by the end of 1993, to make findings and recommendations on "reasonable standards for protection of public health and safety." Within a year later, EPA is to issue revised safety standards "based upon and consistent with" the NAS findings and recommendations. "Such standards shall prescribe the maximum annual dose equivalent to individual members of the public" from the repository and "shall be the only standards applicable to the Yucca Mountain site." No later than one year after EPA issues revised standards, the NRC must modify its regulations to be consistent with those standards and with the recommendations and findings of the NAS study.

Program Mission and Objectives

The program's mission is:

to lead the nation's effort to develop and operate a system for the safe and final geologic disposal of the nation's spent fuel and high-level radioactive waste.

To carry out that mission, the program seeks to achieve four key objectives:

Timely disposal capability: to establish as soon as practicable the ability to safely dispose of radioactive waste in a licensed geologic repository.

Timely and adequate waste acceptance: to establish the ability to accept waste from utilities on a schedule, at rates and in ways that will permit the orderly operation of power plants and the efficient conduct of the overall waste management system.

System flexibility: to ensure that the program can adapt to changing circumstances while keeping its commitments.

External confidence: to earn and build in the external scientific and technical community and the public the levels of confidence needed to achieve the program's mission.

As it seeks to achieve these objectives, the program must be conducted according to three basic principles:

- Human and environmental health and safety are the program's paramount concern.
- The program's scientific and technical work must be of the highest quality, and the external expert community and the public must perceive it to be so.
- The program must be managed efficiently and cost-effectively.

IV. NEED FOR AN ALTERNATIVE STRATEGY

The program's strategy has focused on the achievement of a single large step no country has yet taken – the licensing of a geologic repository designed to isolate 70,000 metric tons of radioactive wastes from the human environment for many thousands of years. Once the repository is licensed, the program would move as rapidly as possible to build a full-scale repository and begin disposing of the bulk of the nation's entire inventory of spent fuel. That strategy was adopted when it was assumed that the Federal government would be able to start accepting spent fuel from utilities at an operating repository by 1998.

The program currently plans to decide on site suitability and, if suitable, submit a license by 2001 at a cost of $6.3 billion. If a license is granted by 2004,

the repository would begin operating in 2010 at an additional cost of almost $3 billion.

The current strategy assumes there is an urgent need to dispose of spent fuel. That assumption did, for very different reasons, represent a common conclusion of key stakeholders in the early 1980s when NWPA was enacted. The nuclear industry and some utilities sought a rapid disposal solution to preserve the nuclear power option. The utilities generally supported an early repository as the means for removing spent fuel from reactor sites. Many environmental and arms control groups favored rapid, safe and final disposal of reactor spent fuel to prevent reprocessing. Most environmentalists opposed any interim or extended storage of spent fuel.

Today, a decade after the enactment of NWPA, views and circumstances have changed. Few, if any, key stakeholders believe there is any urgent safety need for final disposal of waste. Indeed, there is a greater sense today that, while we owe future generations a clear disposal solution, we do not want to present them with anything irreversible or irremediable. Reprocessing is uneconomic in this country and will remain so for the foreseeable future. Moreover, more immediate proliferation concerns have arisen such as the control and disposition of former Soviet nuclear weapons.

Thus, our current strategy rests upon an assumption that is no longer valid. For very different reasons, the program's major stakeholders have expressed dissatisfaction with its progress and performance. Over the past several years, a rising chorus of outside analysis and opinion has called for changing the course and conduct of the program.

Below is a summary of those external criticisms and a discussion of the problems posed by the current strategy.

External Critiques

National Academy of Sciences. In 1990, the National Research Council of the NAS issued a report ("Rethinking High-Level Radioactive Waste Management") concluding that "the U.S. [repository] program, as conceived and implemented over the past decade, is unlikely to succeed." The report described the U.S. program (including the regulations as well as DOE's program) as "unique among those of all nations in its rigid schedule, in its insistence on defining in advance the technical requirements for every part of the multibarrier system, and in its major emphasis on the geological component of the barrier as detailed in 10 CFR 60." The report urged, instead, a more incremental, exploratory approach -- similar to that of Sweden and Canada -- that does not assume everything will go right the first time and that employs conservative engineering to increase confidence and reduce uncertainty.

Nuclear Waste Technical Review Board. In a series of reports since early in 1989, the NWTRB has urged the program to pursue a robust, conservative engineered barrier system to strengthen repository safety and public confidence in that safety. The Board has increasingly expressed frustration at the Department's failure to do so. In its Sixth report, December 1992, the NWTRB observed that DOE's effort to "establish very demanding and unrealistic schedules" had led to schedule slippages and to "the perception that DOE is failing to meet program goals, even though the schedule may have little bearing on the nature of the scientific and technical work under way". The NWTRB expressed its concern that the program's "effort to rush to meet overly demanding schedules could affect the quality of the technical and scientific work".

Congress. At a March 31, 1992 hearing of a Senate Energy Appropriations Subcommittee on the disposal program's proposed budget, Subcommittee Chairman, J. Bennett Johnston and his colleagues seriously questioned the viability of a disposal program whose costs continued to escalate without tangible results to show for it, or even the prospect of a favorable result. They were clearly disturbed at estimated costs of site characterization that had risen from $100 million in 1982 to $6.3 billion now, and at the prospect that it would cost that much simply to find out whether Yucca Mountain is a suitable site. Senator Johnston commented: "The program is broke; it needs fixing."

Task Force on Public Trust and Confidence. At the end of 1992, a Task Force on Radioactive Waste Management of the Secretary of Energy's Advisory Board (SEAB Task Force) issued a draft report concluding that the Department's civilian and defense radioactive waste management activities had "little trust and confidence from <u>any</u> sector of the public" and especially from the environmental community and the public interest groups. The report found that the civilian disposal program "faces

significantly more obstacles if it wants to restore trustworthiness" than does the defense program.

Proposals for Storage Rather than Disposal

Some outside observers and analysts have concluded that, for various reasons (costs are too high, opposition and distrust too great), the current program cannot succeed. They recommend halting the program and pursuing other interim solutions such as storage at reactors or elsewhere and other longer-term solutions such as negotiated siting, reprocessing and/or transmutation, or alternatives to geologic disposal. One study claims that by waiting a 100 years or so technological advances and other factors will make disposal easier and cheaper.

Others have proposed, as an alternative to the current program, that a "repository" be initially licensed and built at Yucca Mountain as an underground storage facility, with work and decisions on licensing it as a repository to occur later over a longer period of time.

Contrast with Other Countries

Such independent bodies as the NAS and NWTRB have urged the U.S. to adopt an approach that more closely resembles the approaches of other countries pursuing geologic disposal. The NWTRB has pointed out that, in significant respects, the U.S. approach differs markedly from the approaches of most other countries:

- The U.S. is alone in pursuing the rapid development of a repository for early disposal of the nation's entire inventory of spent fuel from current reactors.
- The U.S. is alone in seeking to achieve in a single large step the first-of-a-kind licensing of a first-of-a-kind 70,000 metric ton repository.
- The U.S. is the only country without a clear and approved plan for extended interim waste storage as an integral part of its waste management system.
- Besides Germany, the U.S. is the only country that does not plan to rely heavily on the engineered barrier system for long-term waste isolation.
- The U.S. is the only country without a research and development program at an underground facility.
- All other countries have a more flexible approach to licensing and focus on achieving direct safety goals rather than on meeting detailed "subsystem" requirements.

Stakeholder Views and Interests

In a number of public workshops and meetings over recent years, the program's stakeholders have, for very different reasons, expressed their dissatisfaction with key aspects of our current approach. Below is a brief summary of views key stakeholders have voiced.

Congress. Congress is deeply concerned about cost escalation and the lack of results, or clear prospect of results. The key Congressional committees have clearly stated that they expect Yucca Mountain to be studied and developed as a repository unless there are major technical problems with the site. If there are major technical problems, they want to find out sooner rather than later.

Utilities and Ratepayers. Utilities and ratepayers -- who fund the program in return for the service of waste acceptance -- both want an early-as-possible demonstration of disposal as well as timely Federal waste acceptance of fuel stored at reactors beginning in 1998 at a predictable and adequate rate. They also want rigorous cost and management controls. The utilities have raised the prospect of lawsuits if timely waste acceptance does not occur, and the ratepayers could refuse to continue to paying the fee.

Nevada. The State maintains that it was unfairly selected as the single site for study and that the program is proceeding to a predetermined result. The State has also said the site is flawed and should be disqualified. The State wants more sites and disposal alternatives to be considered: assurance that site study is scientifically honest and sound and that any repository operation will be safe; some oversight and control over repository development and operation; no premature commitment to the site that would compromise safety decisions; and adequate benefits and impact compensation should the repository be developed.

Affected Counties in Nevada. The affected counties have a variety of points of view, but generally want to

be sure that their views will be adequately represented and considered in program decisions.

The Nuclear Industry. The industry generally shares the utility and ratepayer concerns and seeks the earliest possible demonstration of disposal in order to preserve the nuclear power option.

Environmental and Public Interest Groups. Many environmentalists believe the program is fundamentally flawed because of the process that singled out the Yucca Mountain site. They fear that the preoccupation with schedules will compromise safety and oppose an MRS because it could become a *de facto* repository. Some environmentalists and public interest groups strongly oppose nuclear power and see the waste problem as a useful obstacle to nuclear power. These have little if any interest in making the disposal program work. Many environmentalists, however, fully support geologic disposal as essential for human and environmental safety. For that reason, they support stringent safety standards and a program that will achieve those standards. These believe the current process may not reach the goal of final and safe disposal. They also criticize the program for not providing enough serious and sustained predecisional involvement for interested and affected parties. A few groups have advocated stopping the program and storing the waste indefinitely while pursuing other solutions.

Independent Technical Groups. The NWTRB has praised aspects of the program, but has expressed fundamental concerns about key parts of it. They believe, for example, we should place much greater emphasis on engineered barriers and on getting underground to find any clear disqualifiers as quickly as possible. The NAS has found our program and regulatory approach far too rigid and prescriptive and also believes stronger emphasis should be placed on engineered barriers.

Reactor States. Reactor States want spent fuel removed from their reactors and the costs of waste management to be controlled. They have been relatively silent about the program since NWPA was passed, but some are beginning to join in the criticism of the Federal government's failure thus far to deliver on its promise to provide a timely waste management system and to raise questions about the expansion of spent fuel storage at reactor sites. They do not want reactors to become *de facto* long-term storage facilities.

Current Program Dilemma

The current strategy could result in spending at least $6.3 billion and waiting until 2001 before deciding whether the site is suitable and whether to seek a license. Such a large "sunk cost" before a decision on whether the effort was worth it or not creates two problems.

First, it poses a huge investment risk. The Congress, the utilities, the ratepayers see the costs continuing to rise with the "results" continuing to recede farther into the future. They worry that we might spend all that time and money only to find that the site is not suitable or that a license is unlikely. If that turns out to be the decision, they would like to see it sooner rather than later. For the later it comes, the more that investment will have been "wasted". Indeed, the program's current profile -- high and escalating costs with little or no clear progress to justify them -- runs the risk of "pricing geologic disposal out of the market," as key program stakeholders may decide to abandon the program and shift to monitored storage instead.

Second, such a huge "sunk cost" poses the problem of irreversible momentum. The State of Nevada, some environmentalists and public interest groups and others worry that, with so much time and money invested in Yucca Mountain, the program simply cannot afford to find the site unsuitable and unlicenseable, even if there are good grounds for doing so. They fear that, in effect if not in fact, the decision on Yucca Mountain has already been made. Only the announcement of that decision is being delayed until 2001.

Moreover, in hinging everything on one distant "all-or-nothing" decision point with no clear decision points in between, and in proceeding to build and operate the entire repository for rapid full-scale disposal, the program is not designed to meet the objectives of timely disposal capability, system flexibility or external confidence.

In summary, the current strategy is not well suited to meeting either the program's objectives or the concerns of its stakeholders.

SAFETY, REGULATIONS, AND "PROOF"

The key question the program faces is how to develop a compelling case – supported by the scientific and technical community and accepted by the public at large – that a geologic repository at Yucca Mountain, if the site is found to be suitable, will be safe for thousands of years. That a repository will be safe for that length of time cannot be scientifically "proved" or physically demonstrated. It can only be predicted with greater or lesser confidence.

The U.S. approach to demonstrating safety has been to set and meet detailed prescriptive regulations that are only indirectly related to safety. The U.S. also places great emphasis on comparing quantitative predictions of the performance of the repository against quantitative regulatory requirements. Other countries take the very different approach of seeking to meet direct safety goals – such as limits on the annual dose of radiation to the most exposed individual – and of relying more on features that provide clear evidence of safety than on quantitative calculations. Two NAS studies (1983 Waste Isolation System Panel report and 1990 "Rethinking" reports) found serious flaws in the U.S. regulations and urged the adoption of a direct safety goal such as a dose limit. The NAS has also criticized the U.S. for its over reliance on and misuse of mathematical models and predictions. Resting all or most of the case for repository safety on such "black box" calculations to demonstrate safety for many thousands of years strains scientific and public credulity alike.

In 1990, the NAS convened a symposium of the "entities that comprise the radioactive waste community" to discuss the U.S. repository licensing requirements. Many felt that the U.S. regulations impose some requirements and criteria that do not ensure real safety, that may force the program to spend considerable time and money on matters that have little or nothing to do with real safety, and that may even prevent the program from pursuing whatever paths can most increase real safety and confidence in that safety.

V. PROPOSED ALTERNATIVE STRATEGY

The strategy outlined below does not require any major legislative changes. By seeking to meet, if not exceed, stringent and direct safety goals, it would meet any regulations that are likely to emerge from the current process of NAS review and EPA and NRC revision. It would more closely resemble the approach recommended by the NAS, the Congressional Office of Technology Assessment, and the Nuclear Waste Technical Review Board.

The proposed strategy would seek to avoid the twin problems of huge investment risk and irreversible momentum that trouble the current program. It seeks to achieve the early licensed demonstration of disposal capability followed by phased repository development and an extended period of testing and monitoring to confirm by actual experience that the repository is working as planned. The program would only commit to spending additional dollars on further work after previous work justifies moving on. Dollars would follow clear decisions and results.

The program would first define a robust repository safety concept that undergoes broad and rigorous outside review. The program would then proceed through a series of smaller, more incremental steps to test that concept and study the "suitability" of the Yucca Mountain site, with clear decision points along the way to determine whether work should or should not continue and, if it should, whether changes should be made. Such an incremental approach would allow the program either to abandon the effort as soon as possible, or to continue and to build increasing levels of confidence in the suitability of the site, the safety of the system, and the soundness of the program. The program would continue to support the Negotiator's effort to find a volunteer host for an MRS and to pursue alternatives such as Federal interim storage and multi-purpose containers (MPCs) for timely acceptance of waste from utilities. The proposed strategy would emphasize the early development of MPCs and of adequate surface storage at the repository to accept spent fuel that an MRS cannot accommodate or should there be no MRS.

ELEMENT 1. EARLY CONCEPTUAL DEMONSTRATION OF A SAFE DISPOSAL SYSTEM

Rationale

With the U.S. regulations under revision, the program will have no clear standards to guide its efforts for at least several years. This makes it imperative that the program develop a robust safety concept -- that can command broad support in the external technical and stakeholder communities --in order to focus the site characterization and repository development efforts according to a clear set and sequence of priorities.

The program has developed a wealth of information and analyses to draw upon in framing such a safety concept. Its basic outline and elements are already well known. What the program has not done well, and what the alternative strategy proposes, is 1) to decide precisely which combination of natural and engineered "barriers" it will rely on to demonstrate that the repository is safe; 2) to describe that combination clearly and crisply; and 3) to submit that description to broad external review. Such a description, or concept, would then serve as the widely understood and agreed upon "hypothesis" whose validity the program would seek to test. As the results of such tests and other data and analyses become available, the concept would be modified as appropriate to reflect increasing understanding about the best combination of barriers to use.

Such a concept would give the program a firm basis for concentrating on those features of the natural and engineered system at Yucca Mountain that can, in combination, offer high margins of safety and are most knowable and demonstrable at reasonable time and cost. Moreover, developing a robust safety concept that has wide technical and stakeholder support and that the broader public can understand and approve may be essential to the success of the program.

Whatever regulations eventually result, merely meeting their requirements by complex mathematical calculations and numerical analyses is not likely to generate in either the technical community or the public the required confidence that the repository will be safe. To build that kind of confidence, the program must show that the repository does more than merely meet a long list of detailed regulatory requirements. It must show that the repository meets or exceeds clear, stringent and direct safety goals, and that it offers high margins of safety through a set of demonstrable, multiple, redundant barriers -- including conservative engineering.

Such a concept would also give the program and its stakeholders, its supporters and its opponents or skeptics, a clear and common understanding of the case for disposal safety at Yucca Mountain that must be demonstrated. The early development of such a concept would enable the NAS to consider it during its study of the regulations, and the NRC and EPA to consider it in revising their regulations. The concept could also offer an overall context for preliminary formal findings by the NRC on elements of the licensing case before submission of the full license application.

Steps

A. **Quickly develop a robust disposal safety concept for Yucca Mountain that would meet or exceed direct and stringent safety goals.**

Define that set of multiple, redundant barriers -- both natural and engineered -- that (both singly and together) are most demonstrable and offer high margins of safety.

The basic concept of geologic disposal calls for placing highly hazardous radioactive wastes in a deep underground mine behind a sequence of natural and engineered barriers that will prevent anything from bringing them into contact with the human environment in harmful forms or amounts. Water is the main intruder the repository seeks to guard against. For that reason, repository barriers are principally chosen and designed to:

- Keep water away from the waste package
- Keep water away from the waste
- Keep any water that may get at the waste from carrying radioactive elements to the human environment in harmful forms or amounts.

In framing a robust safety concept, the program would:

(1) Use multiple and redundant barriers. Given the challenge of "predicting" safety for unprecedented time periods, a robust safety case would rely on a

sequence of different and separate barriers. To the degree possible, none would depend on the other and each could independently assure the safety of the repository for all or much of the time required. Each succeeding barrier (or system of barriers) would come into play only if, and to the extent, that the preceding one should fall short. Taken together, all of the barriers, or barrier systems, should exceed the safety goals. The goals would be met even if a few individual barriers or an entire barrier system did not perform as planned.

(2) Focus on those site features that are most demonstrable and important to safety. Yucca Mountain has many features that could keep radioactivity from any isolated wastes from causing human harm. The challenge is to select those we can best understand and demonstrate. Many features that may, in fact, be the most effective may not be those we can most readily understand and demonstrate. Those features will exist whether we can demonstrate them or not, and we can cite them as additional or backup safety elements. But we cannot base the case that seeks to convince the wider world the repository is safe on unknowable and undemonstrable features.

Features of the Yucca Mountain site that are candidates for selection include:

- Low infiltration of water
- Capillary barrier at the Tiva Canyon/Topopah Springs interface
- The fact that the site has been unsaturated for millennia and is likely to remain so
- Ready drainage through fractures, which assures that waste packages will not be immersed in water
- Sorption in the Calico Hills
- Matrix diffusion in the saturated zone.

(3) Define a conservative engineered system design for the initial license (see box on page 14). We are better able to predict with confidence the future behavior of things we engineer than the future behavior of geologic systems. There will always be uncertainties about the performance of natural systems that no amount of data will reduce appreciably. Indeed, new data often raise new questions whose resolution requires new data which raise new questions. A conservative engineering approach, with a robust, long-lived waste package as its centerpiece, is the most effective way to offset these irreducible uncertainties and increase confidence in the safety of a geologic repository.

A conservative design for the initial license could include:

- Robust shielded waste package to exceed current NRC requirements and provide self-evident retrievability (see box on page 20)
- Conservative initial thermal load chosen to minimize time required to develop a defensible licensing case — smaller packages
- Design features to keep infiltrating water away from the waste packages and facilitate drainage
- Extended ready retrievability (e.g., design for an extended planned period of open operation).

(4) Select the best combination of natural and engineered features. The program would make no arbitrary distinction between natural and engineered barriers, as if one were somehow inherently "safer" or "better" than the other. It would, instead, seek to put together the combination of natural and engineered features that would take fullest advantage of the isolated strengths of each, of what they can add to each other, and of ways they can improve each other's performance. It would focus on developing an overall repository system that the scientific community and the broader public could, with confidence, agree would be safe.

(5) Rely as much as possible on natural and man-made features that have analogs. The NAS and others have questioned the wisdom of resting the case for repository safety solely or mainly on complex mathematical predictions. They have stated that the most powerful arguments for confidence in such predictions can come from pointing to actual situations where radioactivity has already been contained, or natural or man-made materials used in repository engineering have survived intact, for long time periods under conditions similar to those of a repository.

(6) Include specific institutional features that add to confidence in long term safety:

- Extended monitoring, now required by law (The Energy Policy Act of 1992, section 801)
- State/local role in monitoring and in the decision to close the repository

B. Submit the safety concept to broad review by the U.S. and international scientific and technical communities and key U.S. stakeholder groups.

- Publish a report on the safety concept and the tests needed to confirm or refute its key aspects.
- Ask the NAS, the NRC, the ACNW, the NWTRB, the State and counties of Nevada, international groups, and others to review and comment.
- Revise as appropriate based on external review
- Update as required by new data and analysis

ELEMENT 2. EARLY SUITABILITY FINDINGS

Rationale

The current plan provides for periodic suitability reviews during characterization (the first being the Early Site Suitability Evaluation). However, DOE would make only a single formal finding on overall site suitability in 2001. The proposed alternative strategy would call for earlier suitability findings to lower investment risk at each stage and, if the findings are favorable, to increase confidence in the safety of the site. To help ensure the credibility of these findings, the program would provide for regular review by external experts. The program would pursue one of several options to focus its original site suitability guidelines on evaluating the single site at Yucca Mountain, generally following the NAS recommendations on the regulations in the "Rethinking High-Level Waste" report.

Steps

A. Revise the siting guidelines to conform with the intent of the 1987 Amendments Act and the 1992 Energy Policy Act and with the NAS recommendations.

B. Begin EIS scoping as a first step toward evaluating the suitability of Yucca Mountain in terms of the potential environmental, socioeconomic and transportation-related impacts. DOE would evaluate suitability under the environmental, socioeconomic, transportation guidelines as part of the EIS process.

C. Develop a process for regular external peer review. DOE used an external peer panel to review the initial Early Site Suitability Evaluation report. An ongoing process to continue such review would be established.

D. Make an early determination of suitability (higher-level findings) on the pre-closure guidelines and certain post-closure guidelines after completing the first major excavation of the Exploratory Studies Facility (e.g., north-to-south "loop"completed, or single drift in the Topopah Spring unit). This would address preclosure radiological safety; ease and cost of repository siting, construction, operation, and closure; and certain postclosure guidelines that do not require completion of all planned underground tests (e.g., climate, erosion, tectonics, and human interference/natural resources).

E. Prepare a preliminary comprehensive site suitability report

- Address the revised siting guidelines and the potentially adverse conditions of NRC's Part 60
- Issue the report for broad external review and comment
- Submit the report to the NRC for formal review and a preliminary finding along the lines of the "preapplication site suitability review of site suitability issues" under Appendix Q of 10 CFR 50 dealing with reactor licensing.

F. Prepare final suitability review and finding for site recommendation

RATIONALE FOR A CONSERVATIVE INITIAL SYSTEM DESIGN

Current Plan: The current plan for repository development has the implicit objective of disposing of 70,000 tons of spent fuel in the repository as quickly as possible. This requires construction of full-scale waste handling buildings and underground disposal rooms as soon as possible after NRC grants the construction authorization. Because the system (waste package, surface and underground facilities) developed for the license application is expected to be used for the entire 70,000 tons, design efforts emphasize maximizing operational efficiency and minimizing total system life cycle costs. The goal of ramping up to full-scale disposal quickly beginning in 2010 allows no time for a period of small-scale operation so that the full-scale system can be designed based on operating experience and the results of design tests after initial waste emplacement. Instead the system is optimized up front to the extent possible using extensive analyses based on available information, and initial small-scale operations begin after the system design has already been locked in. While technology improvement (e.g., better waste package materials) is anticipated, the plan is not explicitly structured to take advantage of such improvement.

Alternative Approach: The proposed strategy adopts a very different approach that is more typical for a new technology. Initial disposal would begin with small-scale operation using a conservative system design, and the full-scale system would be designed based on experience with the conservative design. To provide a basis for key parts of the alternative strategy (e.g., early publication of a "safety concept", and early suitability findings), and to allow small-scale disposal earlier than would be possible with the current plan for full-scale operation, a conservative initial conceptual design would be developed quickly. The objectives of the conservative design would be:

(1) to be widely viewed as workable,

(2) to reduce the time required for Advanced Conceptual Design by limiting the alternatives that have to be evaluated and compared,

(3) to reduce the time required to collect site data needed to design the system and prove system performance,

(4) to reduce debates on technical issues during licensing,

(5) to lessen the chances that the design will have to be changed because of problems encountered in licensing, and

(6) to maintain flexibility for future improvements.

Minimizing projected total system life cycle cost (which would be appropriate if the design were expected to be used for the full 70,000 tons of spent fuel) would *not* be a primary objective at this stage. A key feature would be "over design": the deliberate use of large design safety factors to avoid having to wait for detailed site data that could support use of lower safety factors. This approach may require, for example, limitations on the amount of waste in each waste package or the total amount of waste that could be emplaced in the repository. The system would be optimized (for cost, operational factors, etc.) *after* demonstration that a licensable disposal concept exists, and experience has been gained at small scale with that concept. Improved technology (e.g., better waste package materials) that might become available in the future could be incorporated at that stage.

ELEMENT 3. FORMAL PRE-LICENSING NRC REVIEWS AND PRELIMINARY FINDINGS

Rationale

The NRC has never before licensed a repository to safely isolate radioactive waste for periods longer than recorded human history. Because there are no precedents for this licensing decision, there is no clear understanding of how much data and analysis will be required to give the NRC "reasonable assurance" that the repository will function properly over such periods. The current Site Characterization Plan represents an effort to anticipate in advance all of the data that might be needed and provide it in the license application, before there is any formal indication from NRC about what level of "proof" of performance is required. This anticipatory approach could involve the investment of billions of dollars in characterization and facility design before the NRC is asked even to begin formal consideration of licensing arguments.

Earlier formal NRC reviews and findings are needed for two major reasons:

1. to more efficiently focus site investigations and design efforts on those issues that are clearly identified by the NRC as central to developing "reasonable assurance," and

2. to base increasing investments in the site on externally-validated increases in the level of confidence that a repository can successfully be developed and licensed.

The current issue resolution process is intended to produce earlier focused interactions and findings through submission of Topical Reports to the NRC for review, but these are still informal.

Steps

A. Formalize the current issue resolution process through seeking formal Preliminary Safety Evaluation Reports (PSERs), recognizing that no issue will be "closed" irrevocably even in the actual licensing process. Issues for formal review to be added in the proposed strategy include:

   - Preliminary site suitability review (above)
   - Long-term performance of conservative waste packages - a multi-purpose container design and a disposal-only design (see box on page 20).

B. Use these interactions as an indicator of convergence to a suitable safety demonstration for the license application

In the current plan, the schedule for the license application is driven by the schedule for completion of the full suite of tests identified in the Site Characterization Plan as possibly needed for the licensing process. In the proposed strategy DOE would proceed with a license application as soon as it became clear through formal interactions with the NRC that a reasonable case for overall compliance could be made. The need for additional analyses and data would then be determined as specific issues were identified in the licensing process.

ELEMENT 4. EARLY WASTE PACKAGING RESEARCH AND DEVELOPMENT (R&D) FACILITY

Rationale

The current program has no explicit provisions for fabricating and testing waste packages and sealing techniques before licensing. No packages would be available for *in situ* waste package tests called for by the NRC until a packaging facility has been built at the repository. Further, there are no plans for an ongoing R&D program during the operational life of the repository to improve on the initial waste package design or to develop special packages (if needed) for the many different types of spent fuel from defense activities that might ultimately require direct disposal.

In the proposed strategy, a waste packaging R&D facility would be developed as early as possible. This facility could also be used to seal the initial multi-purpose units for disposal (or verify seals done at reactors) and, if appropriate, load and seal some repository-only disposal packages. This would produce confirmatory data for the licensing proceeding and a small number of packages for initial emplacement in the repository for design tests after licensing. The facility would have the flexibility to handle a range of waste package concepts and sizes so that it can be used during repository operations to develop improved

waste packages for the "optimized" system and any special-purpose packages that might eventually be needed. Initial operation would focus on the MPC, the disposal-only spent fuel package, and the defense high-level waste package.

Steps

A. Develop a suitable R&D facility. This might be done quickest with a new facility or modified existing facility away from the repository site, if a site and adequate resources are available. If not, it could be done as part of the pilot-scale packaging facility at the repository (see below), although this would delay operation until after the construction authorization for the repository.

B. Begin cold tests with waste packages as soon as initial versions of an MPC and a disposal-only package are available, to provide sealing data for the initial licensing proceeding.

C. Begin operating with live waste in time to provide confirmatory information for the initial operating license and to package a small quantity of waste for emplacement in the repository for design tests as soon as possible after NRC grants the construction authorization.

ELEMENT 5. PHASED DEVELOPMENT OF THE LICENSED REPOSITORY

Rationale

Current plans for repository development focus on ramping up to full scale disposal (3,000 tons per year) quickly after a construction authorization is granted. This requires construction of two full-scale underground disposal rooms and a 3,000 ton/year waste packaging facility before NRC grants permission to receive and emplace any waste in the repository. This approach maximizes the stakes in the very first licensing step by suggesting that once NRC gives an initial go-ahead, DOE will put 70,000 tons of spent fuel into Yucca Mountain relatively quickly. It also requires the additional investment of about six years (and several billion dollars) after the construction authorization before the NRC decides whether to allow the repository to operate. That is, a multi-billion dollar waste packaging facility is built before the NRC has finally approved the waste package itself (along with the site and other engineered features of the repository) for actual disposal. The proposed strategy would follow a phased approach that focuses on an early demonstration of small-scale licensed disposal using the conservative system design, and defers construction and operation of a full-scale disposal system. This would allow the initial demonstration of licensed disposal years earlier than would be possible under the current approach, and permits improvements in technology based on operating experience to be incorporated in the full-scale system design. *In this approach, there would be no acceptance and emplacement of live waste in the repository until after NRC grants permission to receive and possess waste (see box on page 17), which would occur at the same time as receipt of the construction authorization.*

Phased development would meet the program's objective "to establish as soon as practicable the ability to dispose of radioactive waste in a repository licensed by the NRC." At the same time, it would reduce the investment in the site before NRC approves disposal and thereby allay concerns about premature irreversible commitments.

In the proposed strategy, DOE would apply for a construction authorization for a full-scale repository using the conservative system design, but with a phased development and emplacement plan that allows for a license amendment to adopt an optimized design before going to full-scale operation. This approach differs from proposals to seek an initial license for disposal of a small amount of waste (e.g., several thousand tons) using an "optimized" system design, and to return for one or more license amendments to allow emplacement of larger amounts. In the alternative discussed here, the initial license application would specify the total amount of waste that could be emplaced in the repository using the conservative design. This amount might be less than 70,000 tons (if, for example, a low heat load is part of the conservative design.) DOE would seek permission to emplace that total amount into the repository using the conservative design, but would recognize clearly the intention to seek a license amendment before the full amount had actually been emplaced, to allow use of an optimized design which might involve a larger total disposal capacity.

WHY WE REJECT PUTTING WASTE IN A REPOSITORY *BEFORE* A LICENSE

In developing the proposed strategy, the Task Force considered suggestions that small amounts of spent fuel be emplaced underground at Yucca Mountain before licensing to provide operational experience and data for licensing. The term "phased licensing" is often used to refer to some version of waste emplacement before NRC certifies that disposal requirements have been met. Current plans call for no tests with radioactive materials in the site before a license and, thus, for no data on operational issues or large-scale thermal effects until after a license.

The Nuclear Waste Policy Act recognized the potential value of prelicensing tests with radioactive materials in two ways. First, it authorized use of up to 10 tons of spent fuel during characterization, if the NRC certifies that is necessary to provide data for licensing. Second, it authorized, for a period of time, a Test and Evaluation Facility in which up to 100 tons of waste could be emplaced in a fully retrievable mode without an NRC license, but with continuing NRC review.

In deciding whether to recommend emplacement of waste in the repository before licensing, the Task Force weighed several factors:

1. Data from early test emplacement would be useful, but not necessary for licensing. The Site Characterization Plan (SCP) did not include such tests, although NRC staff urged DOE to include "in situ waste package tests to obtain the data needed to verify waste package performance at the time of a license application". (Comment 82, 4-68) The data needed to verify initial predictions about the impacts of introducing a large heat load into the repository can be obtained by confirmatory testing after a license. DOE currently plans to use heater tests to obtain the data needed for licensing.

2. Full radiation controls would have to be imposed underground, thus significantly increasing the costs of characterization without a sufficient offsetting benefit.

3. Legislative amendments could be required.

4. DOE's discussions with stakeholders of pre-licensing emplacement options have made clear that many regard them as simply camouflage for trying to begin disposal before demonstrating its safety.

For these reasons, the Task Force decided that the potential benefits of prelicensing waste emplacement do not exceed the financial and institutional costs. Instead, the proposed alternative strategy calls for limited emplacement as soon as possible after licensing to allow earlier initiation of small-scale design confirmation tests and a more gradual build-up to full-scale emplacement than now contemplated.

Steps

A. Small-scale disposal with a conservative system design

This involves very small initial emplacement to initiate design confirmation tests soon after the construction authorization, followed by emplacement at an increased rate (but still small compared to full-scale) once a pilot-scale packaging facility has been built.

- Design testing using a small amount of waste packaged at the waste package R&D facility (see discussion above.)

NRC regulations (10 CFR 60.142) call for a program of design testing -- "in situ testing of such features as borehole and shaft seals, backfill, and thermal interaction effects of the waste packages, backfill, rock, and groundwater." This program is to begin "as early as practicable" in the "early or developmental stages of construction."

To allow initial licensed emplacement for design testing as soon as possible after the construction authorization, the application for a construction authorization would also include the application for permission to receive, possess, and dispose of waste, thus accelerating the application for an operating license by about five years. The NRC regulations already allow NRC to grant a license to receive and possess after it finds that construction of the storage space required for initial operation [undefined] is substantially complete [10 CFR 60.41(a)(2)]. The current plan is to use this provision to allow disposal to begin after constructing full-scale surface facilities but only a portion of the underground facility (two full-scale disposal rooms); construction of the rest of the underground disposal area would proceed in parallel with waste emplacement over the entire life of the repository. Construction of these surface and underground facilities, rather than any specific provision of the regulations, produces the six year lag between the construction authorization and operating license in the current strategy.

In the proposed strategy, DOE would simply reduce the amount of storage area planned for initial operation, and use the waste packaging R&D facility to prepare the packages. A small experimental drift for design testing would be built quickly after the construction authorization, and a small amount of fuel (e.g., 100-500 tons) would be emplaced as soon as NRC grants permission to receive and possess waste.

- Pilot disposal using a pilot-scale packaging facility built at the repository as soon as the construction authorization is granted. This would provide operational experience at a much larger scale than the design tests, and is a logical intermediate step between those tests and full-scale operation.

This involves a modest modification to current plans (described in the SCP) to construct both pilot-scale (400 MTU/year) and full-scale (3000 MTU/year) waste receiving and packaging facilities (Waste Handling Buildings I and II), with the smaller facility beginning operation several years before the larger. (At the start of operations, the small-scale facility accepts spent fuel. After the large facility begins operation, the smaller facility is dedicated to receiving and packaging spent fuel not requiring consolidation and defense high-level waste.) Since the current approach has the two buildings constructed in parallel after the construction authorization, with the small facility coming into operation a few years ahead of the large one, there is no opportunity to refine the full-scale design based on operational experience with the small facility. The phased development approach simply involves deferring design and construction of the large-scale facility until experience is gained with pilot-scale operation.

Repository surface facility design efforts would be focused on designing Waste Handling Building I. DOE would defer as much of the detailed design of the full-scale facility (Waste Handling Building II) as NRC will allow, recognizing that any design described in the initial license application is likely to be modified through a license amendment. Pilot scale disposal of both spent fuel and defense high-level waste would begin when Waste Handling Building I is constructed. After several thousand tons were loaded, some would be removed to prove retrievability. The facility would also service on-site surface storage of MPCs accepted from utilities before emplacement.

B. Full-scale disposal with "optimized" design

Whenever future decision-makers decide to proceed to full-scale disposal, the system design would be optimized based on complete information from characterization, licensing, and small-scale operation and monitoring. DOE would then complete the design of a full-scale packaging facility appropriate for the optimized system design, and seek a license amendment for construction of the packaging facility and use of the new system design (e.g., new waste packages and higher thermal loads.) Upon receipt of NRC authorization, DOE would construct the packaging facility and proceed to full-scale operation. The repository would be designed to allow it to remain open and monitored for an extended period to confirm that it is performing as expected before a decision on closure. Extended retrievability would be subject to NRC approval, as provided in the NWPA (sec. 122).

ELEMENT 6. SEPARATING WASTE ACCEPTANCE FROM REPOSITORY LOADING

Rationale

Under the current plan, after the repository begins operation DOE intends to meet its obligations to accept waste from utilities through large-scale emplacement in the repository (3,000 tons per year). Interim storage at a Federal storage facility is intended only to provide enough capacity to allow adequate acceptance until disposal begins. The more gradual repository loading plan in the proposed strategy requires additional surface storage after disposal begins in order to meet acceptance obligations. Unless that storage can be provided, utilities and regulatory utility commissions may be reluctant to accept a lower rate of disposal.

NWPA limits the total storage capacity of an MRS to 15,000 tons of spent fuel, an amount that might not be enough to allow adequate waste acceptance with more gradual disposal. It is not clear that an MRS host will be found willing to accept a larger total MRS storage capacity, although limiting the increased storage to the period after the repository has been licensed could allay the concern that expanded storage would become a *de facto* repository.

A conservative system design would include adequate surface storage capacity at the repository to allow retrieval of waste that has been emplaced in the repository. This capacity could also be used as a backup to Federal storage facilities to help ensure continued adequate waste acceptance. The early development of MPCs has the potential of greatly simplifying the surface facilities needed for storage (see box on page 20.)

Steps

A. Seek approval for MPC surface storage as soon as initial small-scale disposal starts. If such storage is required to be available when the initial emplacement for design tests begins, DOE could seek a Limited Work Authorization (LWA) to begin preparation of the surface storage pads before the construction authorization for the repository underground facilities.

B. Use the surface storage capability to demonstrate retrievability of some waste packages.

C. If necessary, use surface storage to complement storage at other Federal facilities.

VI. MANAGEMENT AND INSTITUTIONAL INITIATIVES

Any strategy, no matter how well conceived, will fail if it is not also well executed. It will also fail if it is not carried out in an open and inclusive manner.

We also believe that the program cannot succeed unless it can build greater confidence and credibility in the outside world. To build that confidence and credibility, the program must not just seek, but ensure, as a regular and integral part of the way it does business, the help and involvement of the external scientific and technical community and of the interested and affected parties.

A. Conduct an independent management review.

The proposed alternative strategy seeks to focus the program's resources far more efficiently upon the steady achievement of the capability for safe disposal. Its success will require some fundamental changes in the program's management style and structure.

Of particular importance is the management of scientific investigations to ensure that they are focused on the timely and efficient resolution of questions that are important to determining site suitability and disposal safety.

The NWTRB and others have called for a thorough independent review of the program's organization and management. We believe such a review is essential.

ROLE OF MULTI-PURPOSE CONTAINERS

As part of an initiative to provide interim storage until the repository is available, the DOE plans to investigate and, if warranted, develop a multiple purpose and standardized container system (the multi-purpose container, or MPC) for spent fuel receipt, storage, transport, and disposal. This is intended to minimize required handling of spent fuel assemblies, provide more efficient storage at nuclear plant sites or Federal sites, and possibly reduce total system costs. This concept has the potential for providing a robust disposal package that could be easily stored on the surface at the repository until emplacement for disposal. The MPC concept would be integrated into the alternative approach as follows:

A. Include a MPC-based waste package in the conservative system design

- As part of the MPC initiative, develop one version of the MPC concept that could provide a robust, self-shielded disposal package that can be stored easily on the surface at the repository with minimal surface facilities. The "multi-purpose unit" considered in DOE's initial MPC analysis might serve this purpose. (A multi-purpose unit combines an inner MPC designed to serve as the corrosion-resistant barrier for disposal, with a multi-purpose shielded overpack that provides a corrosion-allowance barrier; the simplest MPC concept does not take disposal credit for the MPC itself, and assumes that this function would be performed by an overpack optimized for disposal and placed on at the repository packaging facility.) Even if such a package proved unacceptable for disposal as-is, it might still be usable as a dual-purpose transportation/storage system that would allow fuel to be stored at reactors, shipped to the repository, and stored there until ready for packaging for disposal.

B. Allow for possible use of a different or modified package if the MPC-based package proves to be unacceptable for disposal as-is

- In parallel, develop a shielded disposal-only package as a backup; if possible, design this package to accept the MPC in the event that it is compatible with, but not sufficient for, the required disposal performance.

- Use the packaging R&D facility to develop techniques for transferring fuel from the MPC-based package to the disposal-only package.

- Design the pilot-scale packaging facility with flexibility to handle any of the alternative packages; after NRC approves a waste package, complete the design of the full-scale waste handling building.

C. Use both the MPC-based package and the disposal-only package in the licensing strategy

- Use both designs in the robust safety concept

- Evaluate the expected disposal performance of both package designs, prepare a Topical Report on each one that appears suitable, and seek a PSER from NRC on each to get an early indication about possible problems in obtaining disposal credit for the multi-purpose unit or in proving the life of either.

D. Use the MPC-based package for surface storage at the repository after licensed disposal begins, to demonstrate retrievability and, if necessary, to complement other surface storage capacity.

B. Institutionalize a systematic process for interaction with the external scientific and technical community.

The likelihood of successful licensing will be increased if the external scientific and technical community (1) see that DOE's work meets the highest scientific standards, and (2) either generally agree with DOE's position on technical issues or believe that any level of disagreement that exists is the sort that is normally to be expected in scientific endeavors rather than the result of poor technical work by DOE.

To ensure that such an environment exists at the time of licensing, the program needs a systematic strategy for engaging the external scientific community in its work before licensing. There should be three general focal points for this strategy:

- Existing scientific/technical groups charged with reviewing aspects of the waste program: the NWTRB, the NRC's Advisory Committee on Nuclear Waste (ACNW), and the NAS Board on Radioactive Waste Management (BRWM).
- The nuclear waste technical community at large.
- The rest of the scientific and technical community.

(1) Existing technical review groups.

If the NWTRB, the ACNW, and the BRWM generally believe that DOE's work is sound, it will help in licensing; if one or more of them is of the opposite opinion, it could create problems. Measures to engage them more systematically include:

- Providing periodic briefings on the status of key issue resolution efforts and of key scientific questions central to the licensing case.
- Requesting that they review topical reports, white papers, etc.
- Inviting staff participation in workshops on key issues: e.g., performance assessment (modelling, scenario selection).
- Asking the BRWM to extend their work in the "Rethinking" report on the subject of what degree of "proof" of repository performance will ever be attainable.

(2) Nuclear Waste technical community at large.

This group is already reasonably well involved.

(3) The rest of the external scientific/technical community.

This community may have the greatest impact on the most members of the general public. Measures to enhance program credibility with the external scientific community could include:

- Presenting papers and panel discussions at scientific/technical society conferences.
- Publishing papers on key scientific issues in the general scientific literature (rather than in nuclear waste-focused journals).
- Expanding "use of expert scientists from outside the program to review and critique detailed aspects and to provide additional professional judgment," as recommended by the NAS "Rethinking" report.
- Creating a scientific advisory body for OCRWM drawing on outside experts.

C. Establish a Stakeholder Advisory Committee, reporting to the program's Director, under the Federal Advisory Committee Act – as DOE's Environmental Restoration and Waste Management program has already done. The membership should be both balanced and fully representative, and the group should be supported by adequate staff and resources.

The program has, on an ad hoc basis, convened stakeholder groups to seek their views on program strategies, but has more commonly dealt with stakeholders separately. The establishment of a standing advisory committee would enable the program to make far more efficient and effective use of the talents and ideas of its stakeholders. By employing such a group as the principal vehicle for interacting with its stakeholders collectively, the program might be able to focus its own resources more effectively than is possible with a myriad of individual interactions and at the same time avoid the

perception that it regards some stakeholders as far more important than others.

The program could also raise its strategic planning process to the same level of visibility and importance as the Five Year Plan process used by the Environmental Restoration program. The plan could be issued annually or biennially as a public document. It would present alternatives currently under evaluation and seek comment on them, and would also describe strategic decisions made since the last plan. The Advisory Committee could serve as a forum for developing the plan and as a vehicle for seeking wider review and revision on the basis of that review.

VII. PUBLIC REVIEW PLAN

External Review and Consensus-Building

The Board on Radioactive Waste of the National Research Council of the U.S. National Academy of Sciences would be an appropriate expert group to review the new program strategy. As part of the review process, the Board could provide an opportunity for external parties to present their views on the alternative strategy. DOE could ask the Board to address the technical merits of the alternative strategy and its chances for success.

Simultaneously, DOE could ask for review and comment by the Nuclear Waste Technical Review Board and the Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste.

To build broader consensus at the same time, DOE could contract with a respected, impartial national consensus-building group to convene one or more stakeholder forums. Stakeholders would be asked to review the alternative strategy.

In parallel, wide public review could be sought through a Federal Register notice and comment period.

VIII. NEXT STEPS

This report proposes an alternative strategy that could serve as the basis for extensive public discussions to find out what strategy comes closest to representing a broad consensus of stakeholders. Thus, the first step toward "implementing" the proposed strategy is to undertake the external review process outlined earlier. Should that process demonstrate that this strategy, or some improved version of it, represents the approach that best meets stakeholder concerns and the program's objectives, the program will need to take several specific steps to turn the strategy from a conceptual description into a program approach that can actually be carried out. Those steps include:

1. Develop the robust safety concept. The program would quickly form an independent group of experts to develop the safety concept over a period of months. At the same time, the program would develop an explicit plan for broad review.

2. Do a "critical path" analysis to 1) identify those actions and accomplishments that pace the program's schedule, and (2) ensure that program plans and resources are applied consistently to the critical activities identified in the analysis.

3. Do a schedule and cost rebaselining to determine the detailed costs and timetables the alternative strategy would entail.

4. Identify all interim milestones and organize the program to achieve them.

Appendix A

Task Force Charter

Senator J. Bennett Johnston, Chairman of the Senate Committee on Energy and Natural Resources, sent a December 10, 1992 letter asking former Secretary James Watkins for information on the Department's plans for disposing of spent nuclear fuel and for beginning to receive such fuel from utilities by 1998. Secretary Watkins sent Senator Johnston a December 17, 1992 letter outlining the Department's plans for ensuring the timely receipt of spent fuel. In a January 12, 1993 letter to Senator Johnston, Secretary Watkins described the Department's plans for disposal of spent fuel. In that letter, Secretary Watkins said the Department was investigating an alternative disposal strategy and would "provide a conceptual revised strategy for public review by April 1, 1993".

At the request of Under Secretary Hugo Pomrehn, Lake Barrett, Acting Director of the civilian radioactive waste program, set up an ad hoc task force to meet Secretary Watkins commitment to provide a revised strategy for public review by April 1, 1993. In framing that strategy, the Task Force was to:

- Evaluate methods of site characterization, design, and licensing
- Critique current schedules and suggest legislative and regulatory modifications
- Evaluate methods for early initial demonstration of final disposal in a suitable licensed-repository while recognizing the first-of-a-kind challenge of providing final confidence that the system will perform as required over geologic time periods
- Explore methods which call for sequential, logical actions in which early emplacement is but one step in a series designed to provide ultimate safety assurance
- Define and evaluate options for "phased licensing".

Appendix B

Program Work on Alternative Strategies

The strategy presented in this report reflects the extensive analyses of alternative strategies that the disposal program has done over the past four years. Those analyses include:

- The 1989-90 "Strategic Planning Initiatives" study. Starting with a series of workshops in the summer of 1989, the program developed a set of strategic options for redirecting the program.
- The 1989-90 "Alternative Licensing Strategies" study. Drawing in part on the "Strategic Planning Initiatives" work, the program evaluated a wide range of licensing options that could shorten that could shorten the repository schedule by more than a year, while meeting all health and safety requirements.
- The 1990-91 "Options for Overcoming Barriers to the Success of the High-Level Nuclear Waste Management Program" analysis. As part of the develop of the National Energy Strategy, the program assessed the key barriers to program success and options for overcoming them.
- The 1990-91 "Strategic Principles" effort. Starting with several stakeholder workshops to discuss both strategic principles for guiding the program and options for shaping it, the program developed a draft amendment to its 1985 Mission Plan.
- The 1992 "Alternative Concepts" analysis. Starting early in 1992, the program conducted an intensive effort – building on the earlier work – to identify and evaluate alternative strategies to better meet the program's objectives and address stakeholder concerns.

PROPOSED ALTERNATIVE STRATEGY

for the Department of Energy's Civilian Radioactive Waste Management Program

Task Force Report

- Since Summer of 1989....

DOE and stakeholders explore disposal program options

Alternative Strategy

Draws on that earlier work
Offers key benefits:

- Achieves licensed disposal in a repository sooner and with smaller investment
- Sets clear interim milestones toward early licensed disposal capability
- Avoids huge investment risk and perception of irreversible momentum
- Uses robust safety concept to focus site characterization

1

Robust repository safety concept

Creates needed guidelines while EPA standard and NRC regs are under review

- Set direct/stringent safety goals
- Define multiple, redundant barriers
- Include those important site safety features most demonstrable (time/cost)
- Employ conservative engineered barrier system/ waste package that exceed regulatory requirements..... *to enhance safety confidence*
- Submit concept for broad review by external scientific and stakeholder community
- Focus site and repository efforts on key safety features

2

Periodic suitability findings during site survey to:

- Lower investment risk
- Increase site safety confidence

Set up ongoing external review process to:

- Ensure credible findings

3

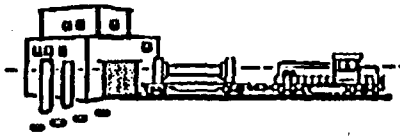
Earlier formal interactions with and preliminary findings by the NRC

- So that increasing site investments CAN BE BASED on increasing confidence that a repository can be licensed

4

An early offsite waste packaging R&D facility to:

- Package small amounts of waste for emplacement in a repository for testing AFTER license is received
- Develop improved waste packages for later integration into system



5

Phased development of the repository after licensing so that:

- Confirmatory testing with actual waste DOES NOT have to wait until full-scale construction and operation
- Full-scale system can take advantage of technological improvements and earlier small-scale experience

Key Steps Include:

- Early licensed demonstration of small-scale disposal using a conservative system design
- Optimize repository design
- Build and operate full-scale facilities when needed
- Design repository allowing extended open operation and monitoring to confirm facility is performing as expected

6

Clear separation of waste acceptance from emplacement in the repository for disposal

- Repository surface storage, *after* a disposal license is received, COULD BE used to allow adequate waste acceptance despite slower loading, IF there is no interim storage facility with adequate capacity

Multi-purpose containers

- NRC licensed for storage, transportation and disposal... COULD allow both acceptance *and storage* with minimal surface facilities and serve as robust, retrievable waste packages

7

Management and institutional initiatives ensure the new strategy is carried out both efficiently and inclusively

- Commission independent review of program organization and management
- Build a process for interaction with external scientific and technical communities to ensure work meets highest standards
- Create a *Stakeholder Advisory Committee* reporting to the program's director

8

Plan for extensive public review to develop as broad a consensus as possible about any changes to the program strategy

- Seek review of the alternative strategy by external technical and regulatory bodies: the Board on Radioactive Waste Management of NAS, the Nuclear Waste Technical Review Board, and NRC's Advisory Committee on Nuclear Waste
- Use a recognized, independent consensus-building group to convene one or more stakeholder forums
- Seek wide public review through a Federal Register notice and comment period

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