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Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste

A Report to the President
and the Congress
in Accordance
with Section 803
of the Energy Policy Act of 1992

PREDECISIONAL DRAFT
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EXECUTIVE SUMMARY

The Energy Policy Act of 1992 requires that the U.S. Department of Energy evaluate its programs and plans to determine whether they are adequate to manage additional waste that may be generated by nuclear power plants constructed and licensed after October 24, 1992.

The Department has evaluated programs and plans mandated by the Nuclear Waste Policy Act of 1982, as amended, specifically those implemented by the Office of Civilian Radioactive Waste Management. In addition to waste that may be generated by new nuclear power plants, the Department considered waste from other sources. Since current programs and plans for the management of nuclear waste as mandated by the Nuclear Waste Policy Act of 1982, as amended, address spent nuclear fuel and high-level radioactive waste from both commercial and defense sources, the adequacy of these programs and plans could not be determined without considering both sources.

The Department has concluded that current waste-management programs and plans are adequate for any additional volumes and categories of nuclear waste produced by new power plants. Those programs and plans are also adequate for managing potential volumes or categories of high-level radioactive waste resulting from the Department's waste-stabilization and disposal programs. The analysis found that:

1. ***Radioactive materials from new nuclear power plants, and most other radioactive materials not managed as part of the current waste-management system, will not be generated until well into the future.*** ~~There will be sufficient time to modify the current programs and plans after the amount of additional waste to be generated by new plants is known. For example, the uppermost projection of new nuclear power plant operation would result in 35 percent more spent nuclear fuel by 2030 than provided for in current plans. Most of this increase would occur between 2020 and 2030, leaving ample time to make program adjustments.~~

2. ***Flexibility has been built into the current programs and plans.*** ~~The system development process, the waste acceptance process, and the cost estimating and cost recovery programs can be adjusted to changing demands on the waste management system. Evaluation of potential additional waste that may be generated after October 24, 1992, indicates that any need for increased storage or disposal capacity can be handled by the current program planning process.~~

3. ***Development of the waste-management system for current waste types will not be significantly affected by the additional waste types envisioned in this evaluation.*** ~~***is at an early stage, allowing ample opportunity to accommodate changing needs.***~~ ~~Major facilities for storage, transportation, and disposal have not been sited, and final designs for their construction have not been developed. Therefore, the system design can be adjusted to meet new requirements.~~

4. *The Department's total inventory of radioactive materials requiring repository disposal will not increase significantly from current amounts.*

The requirement for additional disposal capacity to handle increased quantities of nuclear waste does not necessarily mean that additional repositories will be needed. Only when site characterization has provided enough data will it be possible to determine the first repository's disposal capacity, and only from that can we determine the need for a second repository. The Nuclear Waste Policy Act of 1982, as amended, requires an evaluation of the need for a second repository be done between 2007 and 2010. There is no need for an earlier evaluation.

The Department readily admits that it faces formidable challenges in implementing its programs and plans for managing waste from existing nuclear power plants. Changing circumstances within and outside the Department will add to those challenges and prompt changes in plans and programs. However, the Department does not view this report as the vehicle for addressing those concerns.

This report focuses on provisions of the Nuclear Waste Policy Act, rather than how the Department is currently implementing them. It also focuses primarily on waste that may be generated by new nuclear power plants rather than existing nuclear power plants. With these distinctions in mind, the four findings that led to the conclusions are explained in more detail.

~~These~~ The Department's findings are based on an analysis of two waste-generation scenarios that generate the largest amount of waste. In order to perform a thorough evaluation of current programs and plans to manage potential waste generation, the Department developed two scenarios that would generate large amounts of waste at an early date using reasonable assumptions by authoritative sources.

The first scenario, the upper bound scenario, assumes the maximum amount of spent nuclear fuel from commercial plants and high-level radioactive waste from Department activities. It assumes new nuclear power plants are introduced between 2006 and 2010, and that 70 percent of the existing plants renew their licenses for 20 years; this results in generation of 115,800 metric tons of spent nuclear fuel through 2030. The upper bound scenario also assumes that high-level radioactive waste currently stored at the West Valley Demonstration Project (New York), the Savannah River site (South Carolina), the Idaho National Engineering Laboratory, and the single and double-shell tanks at the Hanford site (Washington) is solidified in 48,900 canisters.

The second scenario, the advanced liquid-metal reactor scenario, assumes the same amount of nuclear power is being generated as the ~~first~~ upper bound scenario, but 19 advanced liquid-metal reactors are deployed between 2012 and 2030 in addition to other advanced light-water reactors. In this scenario, 40,900 metric tons of spent nuclear fuel are reprocessed to supply fuel for the advanced liquid-metal reactors, resulting in ~~generation of~~ a reduction in the amount of spent nuclear fuel from 115,800 metric tons to 74,900 metric tons ~~of spent nuclear fuel~~ through 2030. Reprocessing results in 46,100 packages of high-level radioactive waste, ~~added to~~ in addition to the 48,900 canisters in the first scenario ~~for a total of 95,000 canisters and packages of high-~~

~~level radioactive waste through 2030.~~ The 46,100 packages of high-level radioactive waste from reprocessing would have different characteristics from the 48,900 canisters of high-level radioactive waste from solidifying existing waste at the Department's sites.

The scenarios were not developed to predict or endorse future activities. In reality, future waste generation will differ because actual conditions will not be the same as those assumed in the scenarios. However, the Department is confident that the findings would be valid over a wide range of actual conditions because the scenarios were developed to maximize waste generation and changes in assumptions would most likely result in less waste being generated. Changes in waste projections would not change the Department's findings that current programs and plans are adequate to manage all of the spent nuclear fuel and solidified high-level radioactive waste projected.

In accordance with Section 803 of the Energy Policy Act of 1992, the Department consulted with the Nuclear Regulatory Commission and the Environmental Protection Agency and the Department offered members of the public an opportunity to provide information and comment on the report.

1. INTRODUCTION

In 1982, the Congress enacted legislation for the management of spent nuclear fuel and high-level radioactive waste. The Nuclear Waste Policy Act of 1982 directed the U.S. Department of Energy to site, design, construct, and operate the Nation's first geologic repository for the permanent isolation of these wastes. (For this report, a reference to the Nuclear Waste Policy Act includes its amendments.) The Act established the Office of Civilian Radioactive Waste Management for this purpose.

In 1992, the Congress enacted the Energy Policy Act (Public Law 102-486). Section 803 of the Act directs the Secretary of Energy to report on whether current programs and plans are adequate to manage the volumes or categories of nuclear waste generated by nuclear power plants that might be constructed and licensed after October 24, 1992. The Congress also asked the Secretary to report on additional transportation, interim storage, and geologic repositories needed for these new wastes. Section 803 of the Act is provided in Figure 1-1.

In this report, cases and scenarios concerning the generation of spent nuclear fuel and high-level radioactive waste are used to evaluate the adequacy of current programs and plans with respect to these issues. New nuclear power plants are considered those whose construction would start after October 24, 1992.

The subject of this report is the evaluation, on a programmatic level, of the adequacy of DOE waste management plans and programs to manage additional waste which may be generated by nuclear power plants constructed and licensed after October 24, 1992. For the purposes of this report, it is assumed these programs and plans will proceed in accordance with design, performance, qualitative and quantitative testing and analysis (including environmental, safety, and health), and operations criteria, as well as provisions for state, local, and public interaction as required by applicable laws and regulations. Extensive environmental analyses are required to gain approval to implement these plans. Among the analyses are Environmental Assessments and Environmental Impact Statements required by both the Nuclear Waste Policy Act and the National Environmental Policy Act, as well as site characterization studies and Safety Analysis Reports required by the Nuclear Regulatory Commission. The applicability and adequacy of these environmental analyses would be validated through required federal, state, local, and public interaction processes prior to implementation of waste management operations.

The focus of the evaluation is on additional waste which may be generated by new nuclear power plants, not the waste from existing nuclear power plants. The Department recognizes there are formidable challenges in managing the waste from existing nuclear power plants. Many of those challenges have been delineated by the General Accounting Office and the Nuclear Waste Technical Review Board in recent reports. However, the Department does not view this report as the means for resolving those comments.

SEC. 803. NUCLEAR WASTE MANAGEMENT PLAN.

(a) PREPARATION AND SUBMISSION OF REPORT. – The Secretary of Energy, in consultation with the Nuclear Regulatory Commission and the Environmental Protection Agency, shall prepare and submit to the Congress a report on whether current programs and plans for management of nuclear waste as mandated by the Nuclear Waste Policy Act of 1982 (42 U.S.C. 10101 et seq.) are adequate for management of any additional volumes or categories of nuclear waste that might be generated by any new nuclear power plants that might be constructed and licensed after the date of the enactment of this Act. The Secretary shall prepare the report for submission to the President and the Congress within 1 year after the date of the enactment of this Act. The report shall examine any new relevant issues related to management of spent nuclear fuel and high-level radioactive waste that might be raised by the addition of new nuclear-generated electric capacity, including anticipated increased volumes of spent nuclear fuel or high-level radioactive waste, any need for additional interim storage capacity prior to final disposal, transportation of additional volumes of waste, and any need for additional repositories for deep geologic disposal.

(b) OPPORTUNITY FOR PUBLIC COMMENT. – In preparation of the report required under subsection (a), the Secretary of Energy shall offer members of the public an opportunity to provide information and comment and shall solicit the views of the Nuclear Regulatory Commission, the Environmental Protection Agency, and other interested parties.

(c) AUTHORIZATION OF APPROPRIATIONS. – There are authorized to be appropriated such sums as may be necessary to carry out this section.

Figure 1-1
Excerpt from the Energy Policy Act of 1992

Following through on her commitment made prior to and during her confirmation hearing before the Senate Energy and Natural Resources Committee, and as recommended by the General Accounting Office and the Nuclear Waste Technical Review Board, the Secretary has embarked on a comprehensive review of the program. Upon completion of the elements of the review, early in 1994, the Secretary will issue her findings. The review consists of the following parts:

- An independent financial programmatic review of the Yucca Mountain Project to encompass project financial and business management practices, the project schedule and milestone credibility, and contracting practices.
- An assessment of the process of scientific investigation of the suitability of Yucca Mountain as a repository. The Secretary has already, as a result of this assessment, assigned a senior DOE executive to the post of associate director for geologic disposal, freeing the previously "double-hatted" Yucca Mountain project manager to concentrate on that responsibility only. Additionally, the Secretary has initiated a process to select and assign a senior scientist to coordinate scientific investigation at the project.
- An examination of criticism of the program published over the last several years.
- A consultative process involving a range of program "stakeholders" through which a long-term procedure will be established to include stakeholder interests in program decisions.

The type of wastes addressed in this report include all wastes that are the responsibility of the Department as mandated by the Nuclear Waste Policy Act, including commercial spent nuclear fuel, high level radioactive waste from the Department's defense programs, and other wastes that must be disposed of in a geologic repository. Although the Department believes the immediate concern of the Congress was to determine whether the Department's current programs and plans are adequate to manage the waste from additional commercial power plants, such a determination cannot be made without evaluating the sum total of wastes that would need to be managed under the Nuclear Waste Policy Act.

Similarly, low-level radioactive waste that would result from new power plant operation is not addressed in this report because low-level waste is not covered by the Nuclear Waste Policy Act. It should be understood, however, that the amount of low-level waste will increase if new nuclear power plants are introduced.

The Energy Policy Act included provisions that are expected to lead to simplified procedures for the licensing of nuclear power plants. Such procedures may lead to an increase in the number of new power plants that are constructed and operated in the future, beyond those currently being planned for. In Section 803 of the Act, Congress directed the Department to evaluate what effect the radioactive waste generated by the additional plants would have on programs and plans for waste management. This report focuses on the effect of the additional waste.

The methodology of the scenario analysis is summarized in Section 2. Cases and scenarios are evaluated in Sections 3 through 6. Section 7 describes miscellaneous nuclear wastes that could be emplaced in a geologic repository in the future. The miscellaneous wastes were not included in the cases and scenarios. In Section 8, we present our conclusions based on the scenario analysis in Section 6. Appendix A summarizes relevant programs and plans of the Office of Civilian Radioactive Waste Management. Appendix B describes the partitioning-transmutation technology and its waste materials. Appendix C provides the Department's response to comments on the draft report that was distributed in June 1993. An advanced copy of the final report was provided to the Nuclear Regulatory Commission and the Environmental Protection Agency. Their comments are included as Appendix D and Appendix E respectively.

2. METHODOLOGY

This section describes methods used to develop cases and to analyze scenarios to determine if current programs and plans are adequate. Certain assumptions are applied throughout the analysis:

- Existing and new commercial nuclear power plants produce spent nuclear fuel and high-level radioactive waste through 2030.
- New nuclear power plants are those built or licensed after October 23, 1992.
- Waste production projections through 2030 are based on data from the Energy Information Agency and other sources.
- Waste production estimates are reliable only through 2030, even though ~~some of our scenarios operate through 2052.~~ the upper bound scenario and the advanced liquid-metal reactor scenario would produce waste beyond 2030.

Figure 2-1 shows the steps followed in the preparation of this report:

1. Develop cases which estimate amounts of spent nuclear fuel and high-level radioactive waste generation (Sections 3 through 5 of this report).
2. Combine cases into scenarios, which estimate the total volume of the wastes (Section 6.1).
3. Analyze the scenarios to determine the adequacy of current programs and plans to manage the wastes (Section 6.2). Appendix A describes the current programs and plans.
4. Evaluate the impact of other sources of miscellaneous waste that may be emplaced in a geologic repository but are not assumed in the scenarios (Section 7). The volume of this waste is small compared with the waste included in the scenarios but treatment and disposal options have not been established.
5. Summarize conclusions reached during steps 3 and 4 (Section 8).

The approach to scenario development (and each step above) is described in Section 2.1, which includes the rationale for assuming certain reactor designs, a summary of key assumptions in each scenario, and the calculation of waste production in the scenarios. The approach to analyzing the scenarios is explained in Section 2.2.

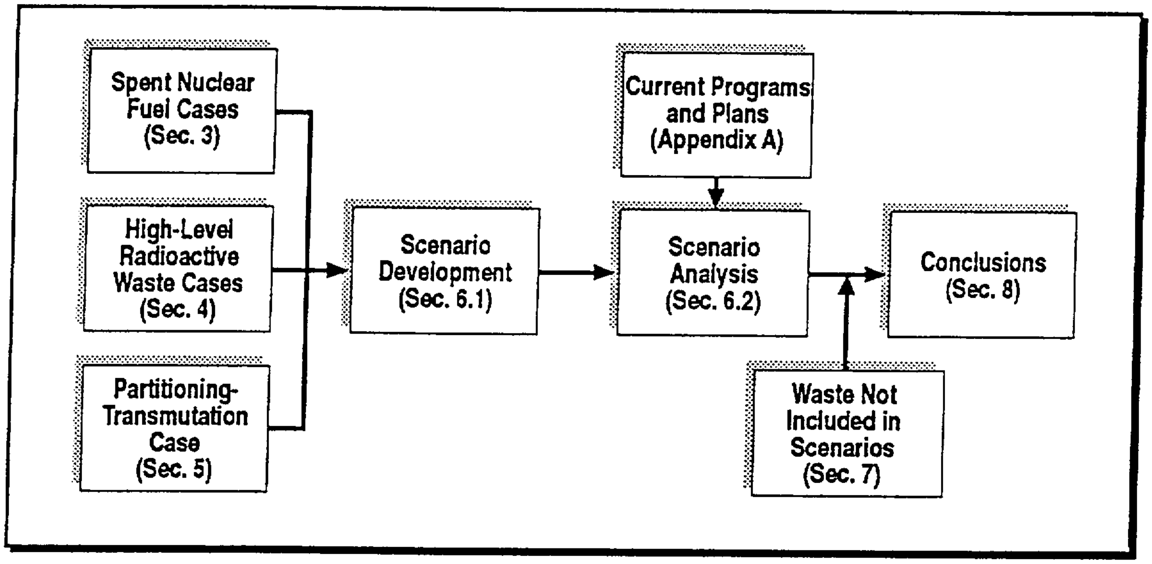


Figure 2-1
Steps of the Scenario Analysis and Corresponding Sections of This Document

2.1 SCENARIO DEVELOPMENT

In order to perform a thorough evaluation of current programs and plans to manage potential waste generation, scenarios were developed that would generate large amounts of waste at an early date using reasonable assumptions by authoritative sources (Figure 2-2). The upper-bound scenario assumes a resurgence of the nuclear power industry and large amounts of solidified high-level radioactive waste generated by Department of Energy activities. The advanced liquid-metal reactor scenario assumes an aggressive deployment of this type of reactor, which significantly alters the composition of waste generated, less spent nuclear fuel and more high-level radioactive waste. A reference scenario was also developed. While not an object of the evaluation, the reference scenario is assumed to be representative of current programs and plans and is provided as a benchmark against which the other scenarios can be measured.

The scenarios were not developed to predict or endorse future activities. In reality, future waste generation will differ because actual conditions will not be the same as those assumed in the scenarios. The scenarios contain large uncertainties because there are ~~large~~ corresponding uncertainties regarding the introduction of new nuclear power plants and the treatment methods to be employed in Department activities.

The upper bound and advanced liquid-metal reactor scenarios include high assumptions about the number of new nuclear power plants for purposes of developing estimates of the volumes of spent nuclear fuel and high-level radioactive waste that result from those reactors. The Department recognizes that there are significant economic, regulatory, and political constraints on new development of new reactors. The scenarios do not represent the Department's expectation of the number of reactors that are likely to be built, nor do they represent the Department's wishes. Instead, the scenarios have been developed to show the upper bounds of waste to be managed in the future by the Department.

2.1.1 Reactor Designs Assumed in the Scenarios

In the reference scenario, existing nuclear power plants are assumed to operate through their 40-year licenses.

In a second scenario, electricity is generated by both existing light-water reactors (70 percent with a 20-year license renewal) and by advanced light-water reactors. The spent nuclear fuel produced by advanced light-water reactors is similar to that discharged from existing reactors.

In the final scenario, 19 new nuclear power plants will use actinide-burning advanced liquid-metal reactors. Electricity is also generated by existing light-water reactors and new advanced light-water reactors. Fuel for the advanced liquid-metal reactors is obtained by pyroprocessing spent nuclear fuel from light-water reactors. This is a partitioning and transmutation process explained more fully in Section 5 of this Report. Advanced liquid-metal reactors are assumed in this scenario because of the potential benefit resulting from their consumption of spent nuclear fuel, which would otherwise require emplacement in a geologic repository.

2.1.2 Key Assumptions of the Scenarios

Table 2-1 describes the cases that make up the scenarios as well as key assumptions of the cases. The types and amounts of spent fuel and high-level radioactive waste that would be produced through 2030 in the following three scenarios are evaluated in this report:

1. ***Reference scenario: No new nuclear power plants are licensed.*** Existing commercial nuclear power plants do not have their licenses renewed and are not retired early. High-level radioactive waste in underground tanks at four sites is solidified and stored in canisters pending disposal in a geologic repository, including 10,000 canisters from the single-shell tanks at the Hanford site.

2. ***Upper bound scenario: A number of nuclear power plants with advanced light-water reactors begin to operate after 2006.*** The spent fuel from the new advanced light-water reactors is similar to that discharged from existing pressurized-water and boiling-water reactors. In addition, the licenses of 70 percent of existing nuclear power plants are renewed for an additional 20 years. High-level radioactive waste produced by reprocessing spent nuclear fuel at four sites is treated, placed in canisters, and stored pending disposal in a geologic repository, including 35,000 canisters from single-shell tanks at the Hanford site.

3. ***Advanced liquid-metal reactor scenario: A number of new nuclear power plants are licensed and constructed after 2006, including 19 actinide-burning advanced liquid-metal reactors.*** Existing light-water reactors and advanced light-water reactors also operate in this scenario. To produce fuel for the advanced liquid-metal reactors, spent nuclear fuel is reprocessed from reactors of all designs. The processing consumes light-water reactor spent nuclear fuel and produces high-level radioactive waste. In addition, high-level radioactive waste produced at four sites is treated, placed in canisters, and stored pending disposal in a geologic repository, including 35,000 canisters from single-shell tanks at the Hanford site.

These assumptions and others explained in Sections 3 through 5 determine the amounts of nuclear waste produced in each scenario.

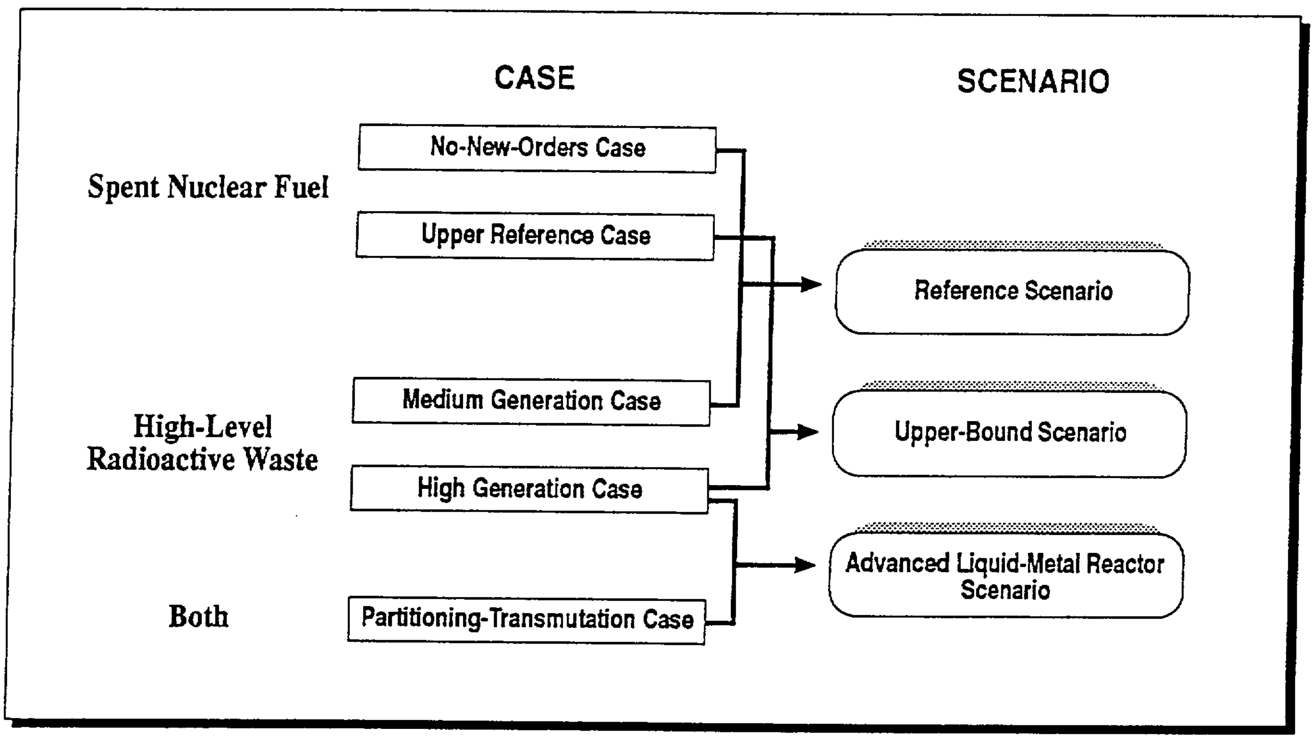


Figure 2-2
Scenario Development

Table 2-1

Composition of Scenarios

	Reference Scenario	Upper Bound Scenario	Advanced Liquid-Metal Reactor Scenario
Reactor Design			
Existing light-water reactors	•	•	•
Advanced light-water reactors (start 2006-2010)		•	•
Advanced liquid-metal reactors (start 2012)			•
Cases That Produce Spent Nuclear Fuel			
No-new-orders case: No-new-orders for commercial nuclear power plants. Licenses of existing plants are not renewed.	•		
Upper reference case: New reactors deployed. Licenses of 70 percent of existing plants are renewed for 20 years.		•	
Partitioning and transmutation case: Advanced liquid-metal reactors deployed. Fuel for those reactors is produced by the pyroprocessing of spent nuclear fuel from those reactors and from light-water reactors.			•
Cases That Produce High-Level Radioactive Waste			
Medium-generation case: High-level radioactive waste at four sites; 10,000 canisters from the single-shell tanks at the Hanford site.	•		
High-generation case: High-level radioactive waste in underground tanks at four sites; 35,000 canisters from the single-shell tanks at the Hanford site.		•	•
Partitioning and transmutation case: Advanced liquid-metal reactors deployed. Fuel for those reactors is produced by the pyroprocessing of spent nuclear fuel from those reactors and from light-water reactors.			•

Note: Assumptions made in the cases are described in Sections 3 through 5. The same amount of power is generated by nuclear power plants in the upper reference case and the partitioning and transmutation case.

2.1.3 Types of Nuclear Waste Produced in the Scenarios

The cases and scenarios produce the following types of nuclear wastes:

1. ***Spent nuclear fuel*** discharged from existing commercial light-water reactors and new advanced light-water reactors: Spent fuel from these reactors is similar. In this report, spent nuclear fuel is discussed in terms of metric tons of heavy metal. (In this report, metric tons are metric tons of heavy metal.)

2. ***High-level radioactive waste:*** The two sources of high-level radioactive waste in the scenarios are (a) canisters of waste produced at four sites, and (b) high-level radioactive waste resulting from the pyroprocessing of spent nuclear fuel from light-water reactors and advanced liquid-metal reactors to create fuel for the advanced liquid-metal reactors. In this report, high-level radioactive waste is discussed in terms of packages and canisters.

The first listed source of high-level radioactive waste comes from underground tanks at four sites: the Hanford site, the Idaho National Engineering Laboratory, the Savannah River site, and the West Valley (New York) site. Much of the waste arose from reprocessing fuel from plutonium production reactors, fuel from U.S. naval reactors, fuel and targets from the Savannah River Production Reactor, and commercial spent nuclear fuel reprocessing. The Department of Energy plans to convert the high-level radioactive waste component into a form that can be placed in canisters and put in a repository.

2.1.4 Calculation of Waste Production in the Scenarios

The amount of nuclear waste generated by a scenario through 2030 is the waste produced by a combination of certain cases. The cases project the generation of either spent nuclear fuel or of high-level radioactive waste, or of both (as in the partitioning and transmutation case with actinide-burning advanced liquid-metal reactors). Each scenario consists of assumptions that determine the types and amounts of nuclear wastes produced through 2030. The amounts and types of nuclear waste produced by scenarios are determined as follows:

1. ***Reference scenario:*** Determined by projecting the amounts generated through 2030 in the no-new-orders case for spent nuclear fuel (Section 3.2) and the medium-generation case for high-level radioactive waste (Section 4.2).

2. ***Upper-bound scenario:*** Determined by projecting the amounts generated through 2030 by the upper reference case for spent nuclear fuel (Section 3.3) and the high-generation case for high-level radioactive waste (Section 4.3).

3. ***Advanced liquid-metal reactor scenario:*** Determined by projecting and adding the amounts generated through 2030 in the partitioning and transmutation case (Section 5)

and the upper-generation case for high-level radioactive waste (Section 4). The partitioning and transmutation case consists of the assumptions of the upper reference case for light-water reactor spent nuclear fuel and the operation of advanced liquid-metal reactors.

The quantity of nuclear wastes produced by the two scenarios with new nuclear power plants represents upper bounds for spent nuclear fuel and high-level radioactive waste. The scenario with advanced liquid-metal reactors is the upper-bound scenario for high-level radioactive waste, and the scenario with new advanced light-water reactors is the upper-bound scenario for light-water reactor spent nuclear fuel.

2.2 SCENARIO ANALYSIS

In Section 6.2, we assess waste-production scenarios and answer the following question: Would the current program and plans of the Office of Civilian Radioactive Waste Management be adequate to manage the additional volumes or categories of nuclear wastes that might be generated by the new commercial nuclear power plants assumed in two scenarios? Specifically the analysis is an evaluation of the following aspects of the program:

1. The need for a second repository.
2. Interim storage of waste.
3. Waste transportation.
4. Waste acceptance.
5. Costs and funding of the program.
6. Regulatory framework for the program.
7. Decision to emplace defense waste and commercial waste in the same repository.

The extent of our analysis of each scenario and its effect on the program was limited by the purpose of this report: to evaluate the adequacy of current programs and plans with respect to the management of additional volumes and categories of waste generated by new commercial nuclear power plants. There are many aspects of the waste-management system that did not need to be evaluated because the results of such evaluations would not have affected our conclusions. For example, we found the current estimate of the potential capacity of a repository at the Yucca Mountain site in Nevada is adequate because current programs and plans include characterization of the site in time to support the evaluation of the need for a second repository between 2007 and 2010. For the same reason, the impact of different volumes and types of wastes on the design of storage and disposal facilities and on the cost of the facilities was not analyzed. We found it unnecessary to establish a common unit of measure for the different waste types that may require geologic disposal. Such an analysis is not necessary to support our conclusions.

3. CASES ON COMMERCIAL SPENT NUCLEAR FUEL GENERATION

3.1 INTRODUCTION

The Energy Information Administration of the U.S. Department of Energy provides independent projections regarding aspects of the commercial nuclear power industry.[1] It has developed three cases to estimate nuclear power capacity, power generation, and spent nuclear fuel discharges (no-new-orders, lower reference, and upper reference). Spent nuclear fuel is defined in this report as "fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing" (42 USC 10101).

The assumptions in the cases are related to the completion dates of nuclear power plants in the construction pipeline, the operating life of existing reactors, the designs of existing and new reactors, and the capacity of nuclear power plants to generate electricity.

The Office of Civilian Radioactive Waste Management uses the no-new-orders case as its reference case for planning (Section 3.2).

Energy Information Administration estimates of the amounts of spent nuclear fuel produced by its upper reference case assume the deployment of advanced light-water reactors which increase nuclear capacity. Its upper reference case assumes that nuclear capacity increases to 105 net gigawatts (electric) by 2000 and reaches 181 net gigawatts (electric) by 2030. The high capacity is driven by growth in the economy and the demand for electricity. Table 3-1 compares the nuclear capacity projected in the upper reference case to the nuclear capacity projected in the no-new-orders case.

The Energy Information Administration's lower reference case assumes that nuclear capacity increases to 104 net gigawatts (electric) by 2000 and reaches 121 net gigawatts (electric) by 2030. This case was not considered in the analysis because it projects less spent nuclear fuel generated by 2030 than the upper reference case.

Greater fuel burnup is assumed in all three cases for spent nuclear fuel. (Burnup is the amount of energy produced per metric ton of enriched uranium.) Utilities have been increasing their burnup levels to reduce fuel costs, to increase the time between refuelings, and to reduce spent nuclear fuel discharge. The design burnup for existing boiling-water reactor units ranges from 33,000 megawatt-days thermal per metric ton during 1991 to 43,000 megawatt-days thermal per metric ton starting in 2007. The design burnup for existing pressurized-water reactor units ranges from 40,000 megawatt-days thermal per metric ton during 1991 to 55,000 megawatt-days thermal per metric ton starting in 2005. The average discharge burnup for existing boiling-water reactors is expected to reach approximately 35,000 megawatt-days thermal per metric ton by 2000. The average discharge burnup for existing pressurized-water reactors is expected to reach about 43,000 megawatt-days thermal per metric ton by 2000.[1]

Table 3-1

Operable Capacity of U.S.
Nuclear Power Plants From 1991 to 2030 in the
No-New-Orders and Upper Reference Cases

Year	Nuclear Capacity (Net Gigawatts Electric)	
	No-New-Orders Case	Upper Reference Case
1991	100	100
1995	101	102
2000	102	105
2005	102	109
2010	98	113
2015	68	134
2020	53	152
2025	25	167
2030	3	181

Source: Reference 1, Appendix H, Table H1; the no-new-orders case assumes no license extension.

For the two spent nuclear fuel generation cases considered in our analysis, the Energy Information Administration has projected spent nuclear fuel discharges through 2030. Figures 3-1 and 3-2 describe the discharge of spent nuclear fuel in the two cases on an average annual basis and on a cumulative basis, respectively, through 2030.

To ensure that projections are reasonable compared with those of other knowledgeable organizations, the Energy Information Administration evaluated several other projections.[1] It concluded that its projections were similar to those of other organizations and attributed minor differences to different assumptions. The Energy Information Administration's projections are reasonable for the purpose of our analysis.

3.2 NO-NEW-ORDERS CASE

For planning, the Office of Civilian Radioactive Waste Management has made assumptions about the types, amounts, and generation rates of spent nuclear fuel. These assumptions make up the Office's reference case for spent nuclear fuel.[2]

The Energy Information Administration defined the no-new-orders case with and without assuming the renewal of nuclear power plant licenses.[1] The renewal is not assumed in the current reference case for the Civilian Radioactive Waste Management Program.

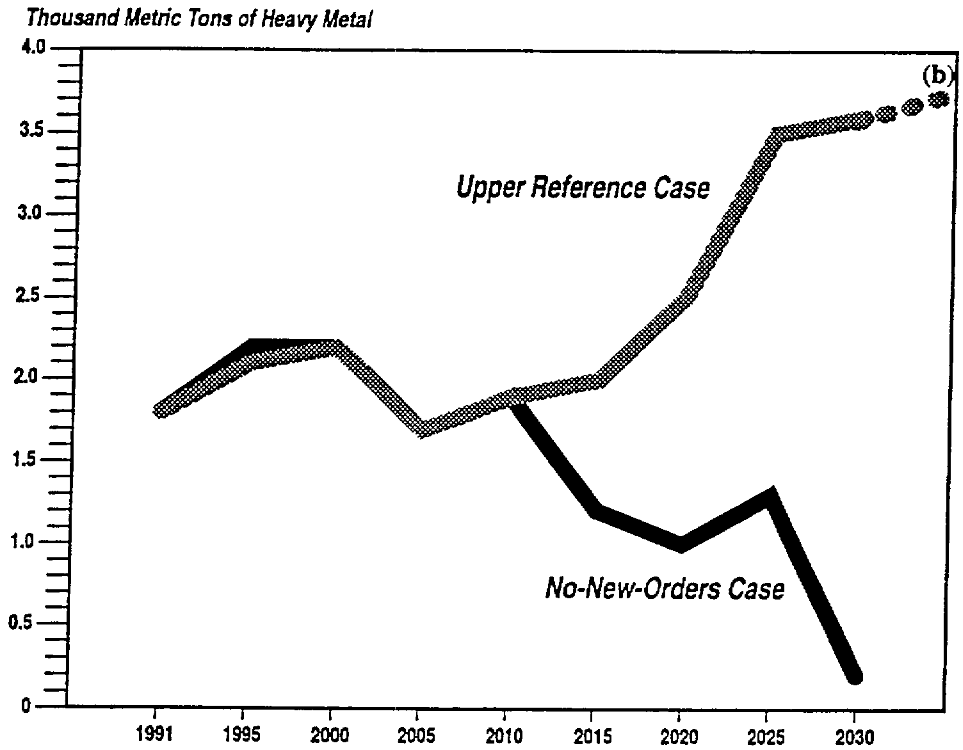
The no-new-orders case consists of these assumptions:

1. No new nuclear power plants are ordered.
2. Plants under construction are completed.
3. Plants operate for 40 years.
4. Nuclear capacity factors remain at 70 percent during plant operation.

In the no-new-orders case, 85,700 metric tons of spent nuclear fuel are discharged by existing light-water reactors through 2030. Spent nuclear fuel generation is expected to be extremely low after 2030 and would cease several years later when the last nuclear power plant shuts down.

3.3 UPPER REFERENCE CASE

The upper reference case assumes that the demand for electricity increases at a high rate and that the portion of electricity generated by nuclear power plants increases. ~~Many~~ Two provisions of the Energy Policy Act of 1992 could contribute to the resurgence of the nuclear power industry assumed in this case. Title XXI, Subtitle C, requires the Secretary "to carry out civilian nuclear programs in a way that would lead toward the commercial availability of advanced nuclear reactor technologies." Title XXVIII amends the Atomic Energy Act to facilitate the standardization of nuclear power plants and provides explicit authority for the issuance of combined construction and operating licenses.



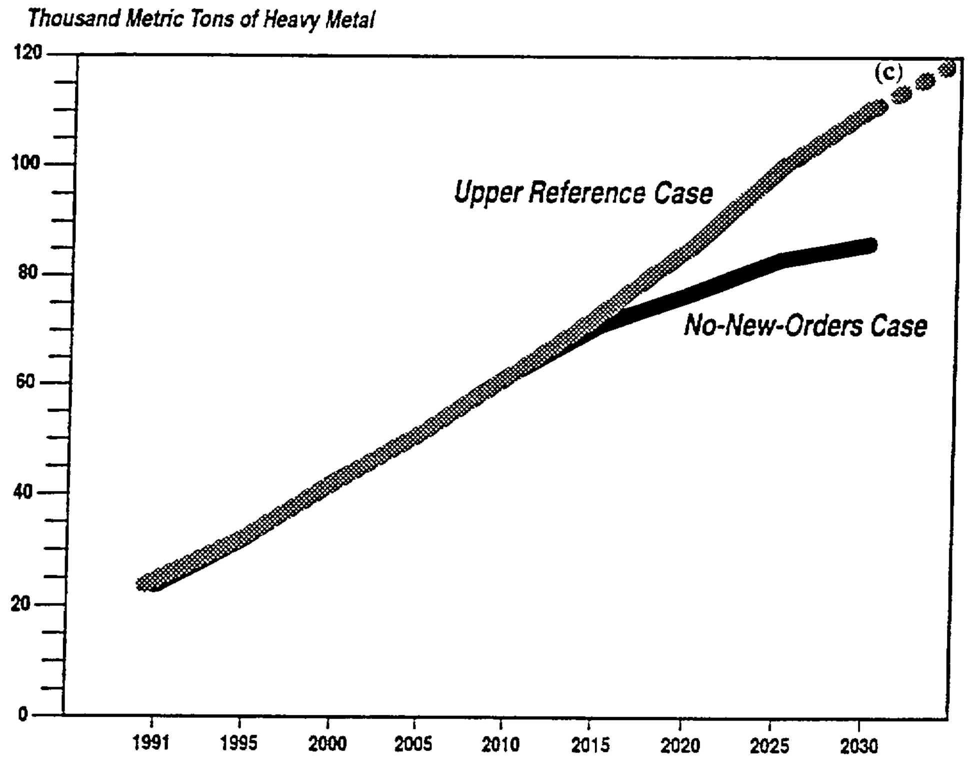
Year	Spent Nuclear Fuel Discharged *(Thousand Metric Tons)* (a)	
	No-New-Orders Case	Upper Reference Case
1991	1.8	1.8
1995	2.2	2.1
2000	2.2	2.2
2005	1.7	1.7
2010	1.9	1.9
2015	1.2	2.0
2020	1.0	2.5
2025	1.3	3.5
2030	0.2	3.6

Source: Reference 1.

(a) Metric tons means metric tons of heavy metal.

(b) Reliable projections are not available beyond 2030.

Figure 3-1
Amount of Spent Nuclear Fuel Discharged Annually by the No-New-Orders Case and the Upper Reference Case



Year	Cumulative Spent Nuclear Fuel Discharged (b) *(Thousand Metric Tons)* (a)	
	No-New-Orders Case	Upper Reference Case
1991	23.7	23.7
1995	32.2	32.1
2000	42.4	42.3
2005	51.8	52.1
2010	61.1	61.7
2015	71.2	73.0
2020	77.1	85.5
2025	83.0	100.1
2030	85.7	115.8

Source: Reference 1.

(a) Metric tons means metric tons of heavy metal.

(b) The cumulative amounts of spent nuclear fuel discharged from nuclear power plants include all spent nuclear fuel that was not reprocessed by the Federal government and that was not scheduled for reinsertion in the same reactor. Commercial nuclear power production began in 1957.

(c) Reliable projections are not available beyond 2030.

Figure 3-2
Cumulative Amount of Spent Nuclear Fuel Discharged by the No-New-Orders Case and the Upper Reference Case

The upper reference case consists of the following assumptions:[1]

1. Nuclear generating capacity is driven by high growth in the economy and in the demand for electricity.

2. The share of electricity that is generated by nuclear power eventually exceeds current conditions.

3. There will be new orders for plants with advanced light-water reactors after 2006 which will increase the capacity to generate electricity. A limited number of the new plants with such reactors will begin to operate between 2006 and 2010. From 2010 through 2030, the capacity of plants to generate electricity will increase at an average annual rate of 2.4 percent. The capacity during 2030 will be 181.2 net gigawatts (electric).

4. The operating licenses of 70 percent of the existing nuclear power plants (whose construction began before October 24, 1993) will be renewed for 20 years.

5. Nuclear power plants whose operating licenses are not renewed will operate for 40 years.

6. Capacity factors will remain at 70 percent through 2010 but subsequently increase to 75 percent by 2030.

There are many variables to be considered in estimating the number of new reactors resulting from a projected increase in nuclear energy generating capacity envisioned by the upper reference case. The type of reactor (whether advanced or a current design), average reactor size, burnup rates and capacity factors (and other measures of thermodynamic and economic efficiency), the extent of life-extension programs for existing reactors, and advances in technology could have large impacts on the number of new reactors required to fulfill the upper reference case projection. For this report, a simplistic calculation was made to estimate that, between 2010 and 2030, four or five new reactors per year would be necesary to arrive at 181.2 net gigawatts (electric). This assumes that about 70 net gigawatts (electric) are produced by license renewal of 70 percent of existing plants and the remaining 111.2 net gigawatts (electric) are produced by new 1300 megawatt (electric) reactors. Smaller 600 megawatt (electric) reactors may also be available but it is assumed that utilities would choose the larger reactor if the demand for electricity were as large as the upper reference case assumes.

In the upper reference case, the cumulative amount of spent nuclear fuel discharged by 2030 is about 115,800 metric tons. Spent nuclear fuel will continue to be generated after 2030. For this report, we assume the rate of generation after 2030 will be the same as the rate of generation immediately preceeding 2030. This is depicted by dotted lines in Figures 3-1 and 3-2.

4. CASES ON HIGH-LEVEL RADIOACTIVE WASTE GENERATION

4.1 INTRODUCTION

The Department of Energy is responsible for high-level radioactive waste stored at four sites: the West Valley Demonstration Project (New York), the Savannah River site (South Carolina), the Idaho National Engineering Laboratory, and the Hanford site (Washington). High-level radioactive waste is formally defined as "the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that the [Nuclear Regulatory] Commission, consistent with existing law, determines by rule requires permanent isolation" (42 USC 10101). To improve the safety and stability of high-level radioactive waste during storage and disposal, the Department of Energy plans to concentrate and immobilize the waste in stainless steel canisters. The canisters will be stored on-site pending disposal in a geologic repository.

Two cases concerning the high-level radioactive wastes at the four sites are evaluated in this section: the medium- and high-generation cases. Their assumptions pertain only to the types of high-level radioactive waste and the number of canisters that would be produced by the four sites through 2030. In both cases, all canisters are 2 feet in diameter and 10 feet long, and they contain a glass or a glass-ceramic waste form.

The data in this section comes primarily from the 1992 Integrated Data Base.[3] Many of the assumptions and projections in the 1992 Integrated Data Base are being reconsidered by the Department at this time. Specifically, the Department has decided to shut down the production reactors and to phase out reprocessing at the Savannah River site, the Idaho National Engineering Laboratory, and the Hanford site. The phase-out of reprocessing is discussed in Section 6.3.4. These changes could result in a significant reduction in the amount and type of defense waste that will be generated relative to that discussed in this section. As noted in Section 2, the cases were not developed to predict or endorse future activities.

Most of the uncertainty in the number of waste canisters that will be generated at the four sites comes from the Hanford site. At the Hanford site, between 10,000 and 35,000 canisters of treated and vitrified high-level radioactive waste could be produced from materials now stored in single-shell underground tanks.[3] The difference is due to how the existing waste in the single-shell tanks will be treated. More advanced treatment methods to separate high-level waste components from other waste in the tanks would result in 10,000 canisters. Less advanced treatment methods would result in 35,000 canisters. Extensive treatment of the tank waste could produce fewer than 1,000 canisters of high-level radioactive waste, but this treatment was not considered in the analysis because it generates fewer high-level radioactive waste canisters than do the medium-generation and high-generation cases.

The cases analyzed in this section differ only in the assumed methods used to treat the single-shell-tank waste at the Hanford site. (These methods are described in Sections 4.2 and 4.3) The chosen waste-treatment method is one factor that determines the number of canisters produced in each case. In the medium- and high-generation cases, it is assumed that 10,000 or 35,000 canisters, respectively, of high-level radioactive waste are produced.

In the medium- and high-generation cases, 23,900 and 48,900 canisters, respectively, of high-level radioactive waste are produced collectively by the Hanford, West Valley, Savannah River, and Idaho sites. Except for the assumption pertaining to treatment, all other assumptions of the medium-generation case hold for the high-generation case. High-level radioactive waste is produced in both cases through 2030.

4.2 MEDIUM-GENERATION CASE

The medium-generation case is the benchmark against which the high-generation case in Section 4.3 can be measured. The medium-generation case consists of the assumptions explained below regarding the high-level radioactive wastes in underground tanks at the four sites. Waste is produced in this case from 1999 through 2030.

In this case, 23,900 canisters of high-level radioactive waste will be produced by 2030 at vitrification or solidification plants at the four sites. Table 4-1 lists the number of waste canisters produced by these plants at the four sites and the annual rates of production.

West Valley Demonstration Project

West Valley has on-site approximately 1,800 cubic meters of high-level radioactive waste, which exists primarily as an alkaline liquid in an underground steel tank. The waste was produced by reprocessing commercial spent nuclear fuel and Hanford N-Reactor fuel. The alkaline liquid will be passed through ion-exchange columns, and the resulting sludge will be vitrified and poured into waste canisters. It is estimated that 300 canisters will be produced at the site from 1996 to 1998, at the rate of 100 canisters per year.[3]

The New York Energy Research and Development Authority owns the West Valley site, facilities, and high-level radioactive waste. The West Valley Demonstration Project Act (PL 96-368) authorized the Department to conduct a project at the site to demonstrate the solidification for disposal of liquid high-level radioactive waste. The Department of Energy will take title to the solidified high-level radioactive waste once the Authority pays the necessary disposal fees and the waste reaches the geologic repository.

Table 4-1

High-Level Radioactive Waste Produced in the Medium-Generation Case

Site	Number of Waste Canisters	Annual Rate of Canister Production	Waste Production Period
West Valley	300	100	1996-1998
Savannah River Site	5,400	200-400	1993-2010[a]
Idaho National Engineering Laboratory	6,900	200-400	2015-2030[b]
Hanford Site	11,300	300	1999-2030[b]
Total	23,900	–	–

Source: Reference 3.

(a) Subsequent to the 1992 Integrated Data Base, it has been reported that vitrification will not begin until 1995.

(b) For this report, it is assumed that all canisters are produced by 2030. The actual end date may extend beyond 2030.

Savannah River Site

Approximately 128,000 cubic meters of high-level radioactive waste are stored in underground double-wall steel tanks at the Savannah River site. The waste consists of alkaline liquid, sludge, salt cake, and precipitate. This high-level radioactive waste was produced by reprocessing nuclear fuels and targets from production reactors.[3]

The waste will be processed, vitrified and poured into canisters. It has been assumed for this case that one production reactor will operate from 1993 to 2007. The spent fuel from the reactor will be reprocessed, and the waste will be vitrified starting in 1993. ~~(Subsequent to the 1992 Integrated Data Base, the Department decided not to restart the production reactor and has delayed the start of vitrification until 1994.)~~ It is estimated that 5,400 canisters will be produced at the Savannah River site from 1993 to 2010, at a rate of between 200 and 400 canisters per year.[3] ~~The Department of Energy decided to phase out the reprocessing of spent nuclear fuel. The effect of this decision on our analysis is discussed in Section 6.3.4.~~

Although used as a basis for this report, the Department has since decided not to restart the production reactor and has decided to phase out the reprocessing of spent nuclear fuel. The effect of the Department's decision to phase out reprocessing is discussed in Section 6.3.4. Further, the start of vitrification has been delayed from 1993 to 1995. The Defense Waste Processing Facility at the Savannah River Site is currently in full-scale testing in preparation for waste qualification runs, during which the process for producing vitrified waste will be verified. According to the current schedules, the production of radioactive glass canisters will not begin until 1995.

Idaho National Engineering Laboratory

At this site, about 6,800 cubic meters of liquid high-level radioactive waste are stored in underground steel tanks. In addition, about 3,600 cubic meters of radioactive calcine powder are stored in steel bins. The calcine was produced primarily by reprocessing spent nuclear fuel from naval reactors and from the Department's reactor-testing programs. The 1992 Integrated Data Base projects that fuel delivery, reprocessing, and waste management at the site will continue through 2030. However, subsequent to issue of the 1992 Integrated Data Base, the Department decided to phase out reprocessing of highly enriched fuels. The effect of this decision on our analysis is discussed in Section 6.3.4.

Methods for immobilizing the waste at the laboratory are being evaluated; a "reference waste form" and process may be identified during the 1990s. Assuming that calcine is not disposed of on-site and that inert materials are not removed from the waste stream, about 6,900 canisters containing a glass-ceramic waste would be produced from 2015 to 2030 (i.e., 200-400 canisters per year).[3] The Department is investigating some treatment methods that would allow greater concentration of waste, resulting in a reduction of canisters by a factor of ten.

Hanford Site

At this site, single-shell tanks hold about 164,500 cubic meters of high-level radioactive waste as liquid, sludge, and salt cake. In addition, about 92,000 cubic meters of high-level radioactive waste as a slurry are stored in double-shell tanks. This waste was generated by reprocessing production reactor fuel. Most of the strontium-90 and cesium-137 nuclides were removed from the waste, and the high-level radioactive waste was solidified, encapsulated, and stored in a water basin.[3]

Remediation of the Hanford site is subject to an agreement among the Department of Energy, the Environmental Protection Agency, and the State of Washington. The agreement calls for stabilization and treatment of the waste in a form suitable for disposal in a repository.

It is assumed that

1. The fuel-reprocessing plant at the site will not be restarted.

2. The irradiated fuel will remain in wet storage.

3. A waste-treatment plant will be constructed on site. It should be noted that the Energy Secretary is reviewing plans for vitrification at the Hanford site. However, we assume for this analysis that the canisters will be produced starting in 1999.

In the medium-generation case, waste from the double-shell tanks is processed to produce 1,000 canisters of vitrified waste. Strontium and cesium capsules are placed in another 300 canisters. The contents of the single-shell tanks will be processed, generating 10,000 canisters of high-level radioactive waste.

Alternative strategies for the Hanford high-level waste vitrification program are being evaluated. A program known as the Tank Waste Remediation System is currently underway; part of its mission is to characterize the wastes in the tanks, and to recommend methods of pre-treatment for vitrification subsequent to removal of the liquid wastes from the tanks. Construction of the Hanford Waste Vitrification Plant was put on hold in March 1993 to allow time to consider, among other possibilities, the design of a high-capacity melter to enable the production of larger waste canisters. Also, characterization of all tank wastes (not just the double-shell tank wastes) is to be performed. The Hanford Waste Vitrification Plant was originally designed to be a duplicate of the Defense Waste Processing Facility at the Savannah River Site.

4.3 HIGH-GENERATION CASE

In the high-generation case, high-level radioactive waste is produced through 2030. It is assumed that 35,000 canisters of high-level radioactive waste will be produced from the single-shell tanks at Hanford. The single-shell tank waste undergoes partitioning to separate cesium, strontium, technetium, and transuranic elements. The best available technology is used to remove sodium and other soluble compounds from the tank waste. The waste does not undergo further separation or processing. The waste is vitrified to increase safety and stability during storage. All other assumptions of the medium-generation case regarding waste generation at the West Valley Demonstration Project, the Savannah River site, the Idaho National Engineering Laboratory, and the double-shell tanks at the Hanford site hold for the high-generation case.

In the high-generation case, 48,900 canisters of high-level radioactive waste are produced by the four sites through 2030.

5. PARTITIONING AND TRANSMUTATION CASE FOR SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE

5.1 INTRODUCTION

~~In radioactive waste management, partitioning refers to the extraction and separation of radioisotopes from spent nuclear fuel or from other wastes for reuse, treatment, or disposal. Partitioning is used to extract economically valuable materials such as uranium and plutonium. Transmutation is the conversion of radionuclides to shorter lived or stable isotopes, typically through neutron capture or neutron induced fission. During recent years, interest in partitioning and transmutation as a waste management strategy has been renewed by technical advancements.[4,5] Several technologies are available for partitioning and transmutation. In this case, pyroprocessing of spent nuclear fuel is assumed for partitioning and advanced liquid metal reactors are assumed for transmutation. Other technologies are discussed in Section 6.3.5. At the Department's request, the National Research Council of the National Academy of Sciences and the National Academy of Engineering has undertaken a study of how the technologies of partitioning and transmutation might affect the national program for handling high level radioactive waste. A report is expected to be issued by 1994.~~

~~Advanced liquid metal reactors can be designed to consume actinides obtained from light water reactor spent nuclear fuel, which would otherwise require disposal in a repository. (Although advanced liquid metal reactors can be designed for the net production of plutonium and other fuel materials, an "actinide burning" design, which results in the net consumption of these materials, is assumed here.) Each advanced liquid metal reactor will undergo numerous refueling cycles during its lifetime. During each cycle, only a fraction of the actinide fuel is consumed by fission. Therefore spent nuclear fuel from this reactor may be reprocessed to extract fission products. Remaining actinides can be used in new reactor fuel. For the actinide-burning reactors discussed here, additional fuel must be supplied during each fuel cycle to replace the actinides consumed by the reactor. These actinides can be obtained by reprocessing spent nuclear fuel discharged by light water reactors or from recycled defense materials.~~

~~Section 5.2 describes the assumptions made in the partitioning and transmutation case, and the nuclear waste produced by the case is discussed in Section 5.3.~~

In radioactive waste management, partitioning and transmutation may be accomplished by pyroprocessing light-water spent nuclear fuel to recover for reuse some of the materials that would otherwise be emplaced in a repository. Partitioning refers to the extraction and separation of radioisotopes from spent nuclear fuel or from other wastes for reuse, treatment, or disposal. Transmutation is the conversion of radionuclides to shorter lived or stable isotopes, typically through neutron capture or neutron-induced fission. Several technologies are available for partitioning and transmutation; this case assumes the use of pyroprocessing and advanced liquid-metal reactors. These two technologies are described in more detail in Appendix B, and other available partitioning and transmutation technologies are discussed in Section 6.3.5.

During recent years, interest in partitioning and transmutation as a waste-management strategy has been renewed by technical advancements.[4,5] The Department of Energy is studying advanced liquid-metal reactors and pyroprocessing. Advocates of these technologies believe they may be helpful in managing nuclear wastes. Possible benefits include:[6,7]

- More compact emplacement of waste in a repository because most of the long-term heat load after 300 years would be eliminated and because there is no possibility of criticality in the wastes.

- Use of the highly radioactive and long-lived portions of radioactive waste as fuel in advanced liquid-metal reactors to produce electricity.

- More compact waste forms, resulting in less volume and mass of radioactive waste for disposal.

- Reduced demand for uranium mining and milling since spent fuel will be used as new fuel for advanced design reactors.

- Very low levels of radioactivity within the repository in about 300 years because of natural decay.

However, critics of these technologies have also pointed out a number of disadvantages, including:

- Limited potential increase in repository capacity since the *initial* heat output of wastes will not be greatly reduced.[7,8,9]

- Limited reduction in the number of waste containers sent to a repository.[8]

- A very long time of reactor operation needed to significantly reduce the inventory of transuranic actinides that would otherwise be sent to a repository.[8]

- Negligible reduction of the radiation dose risk from a repository, since the radionuclides which contribute most to repository risk under non-disruptive conditions (technetium-99 and iodine-129) are not removed by actinide burning.[10,11]

- Lengthy and complex siting and licensing processes, with uncertain chances of success, for the first-of-a-kind nuclear facilities needed for actinide recycling.[12]

- No economic incentive apart from government financing for utilities to adopt actinide recycling since it is more expensive than either the once-through nuclear fuel cycle or other means of power production such as coal.[13,14]

- New wastes and waste forms whose properties are not well known and for which it may be difficult to arrange disposal.[5,14]

The deployment of actinide recycling technologies is evaluated in this report because it would clearly affect the types and quantities of radioactive waste generated by new reactors. However, this report does not attempt to present any conclusions or recommendations concerning the likelihood or desirability of these technologies. At the Department's request, the National Research Council of the National Academy of Sciences and the National Academy of Engineering have undertaken a study of how partitioning and transmutation technologies might affect the national program for handling high-level radioactive waste. A report is expected to be issued by 1994.

Section 5.2 describes the assumptions made in the partitioning and transmutation case, and Section 5.3 discusses the nuclear waste produced by the case.

5.2 DESCRIPTION OF THE PARTITIONING AND TRANSMUTATION CASE

Significant use of partitioning and transmutation technologies would be unlikely in the no-new-orders case and lower reference case. Therefore the upper reference case was used to develop the partitioning and transmutation case. The partitioning and transmutation case extends to 2030, as does the upper reference case. The partitioning and transmutation case ~~consists of~~ includes all assumptions of the upper reference case ~~and~~ as well as the following additional assumptions:

1. New nuclear power plants ~~with~~using advanced liquid-metal reactors begin commercial power production during 2012. The total capacity of these new reactors increases to 27 gigawatts (electric) by 2030, and ~~will require~~is accomplished by the deployment of about 19 advanced liquid-metal reactors of 1,395-megawatt (electric) capacity (about one new reactor per year). The total annual power production is the same as in the upper reference case.

2. The design of the new advanced liquid-metal reactors is identical to that of the reference reactor developed by the Office of Nuclear Energy (Department of Energy). Key specifications for the reactors include a ~~homogeneous core design and a~~ power rating of 1,395 megawatts (electric) per reactor and an actinide-burning core design.~~ is also assumed.~~

3. The fuel cycle of the advanced liquid-metal reactor is shown in Figure 5-1. Initial fuel loads are obtained by the pyroprocessing of spent nuclear fuel from light-water reactors. Makeup fuel is also produced by this means as well as by pyroprocessing spent nuclear fuel from the advanced liquid-metal reactors. No further partitioning of specific radionuclides (e.g., cesium, strontium, or iodine) or transmutation of these nuclides by other means, such as accelerators, is performed.

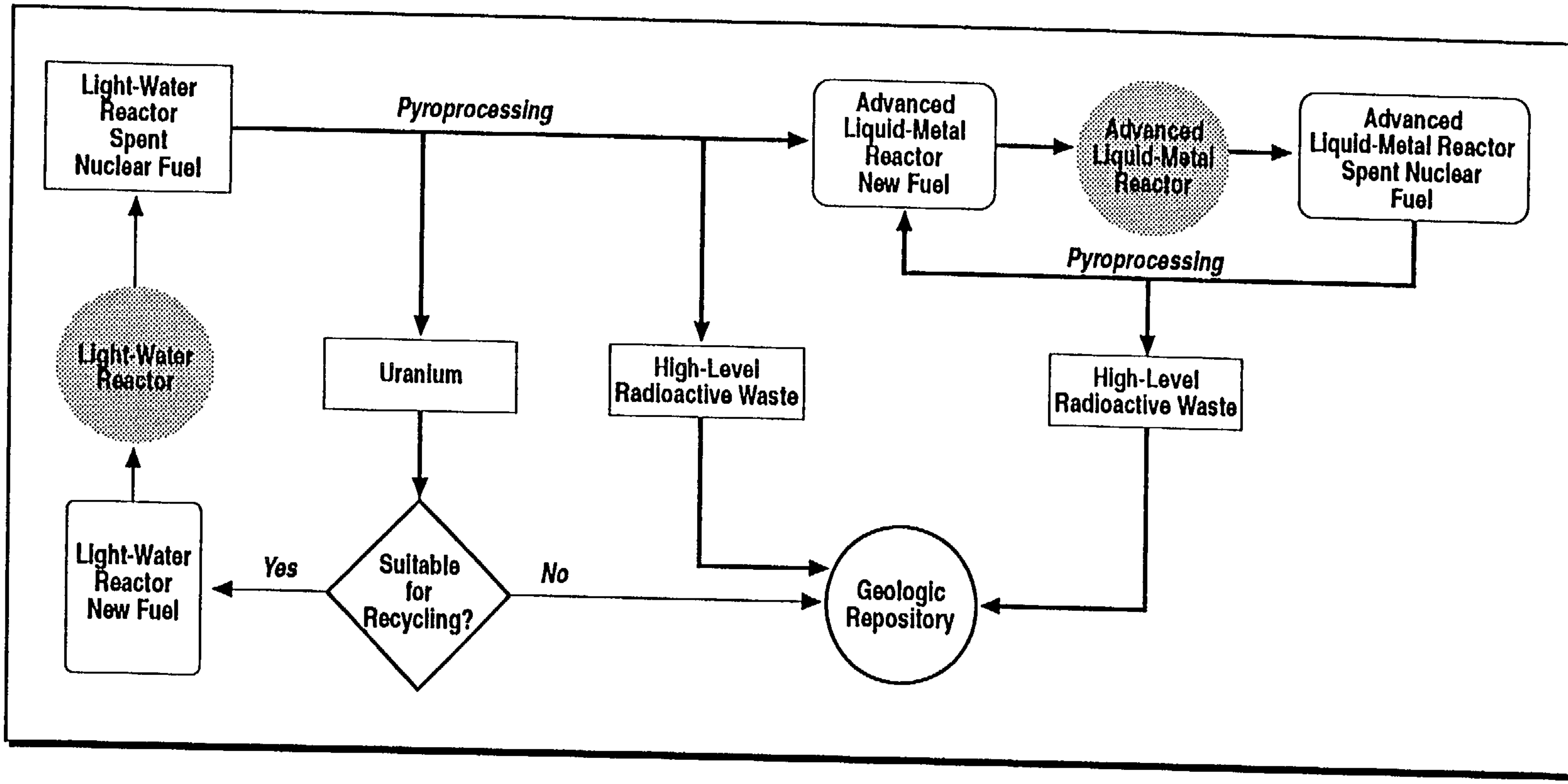


Figure 5-1
Material Flowpath for High-Level Radioactive Waste and Spent Nuclear Fuel for the Partitioning-Transmutation Case

5.3 WASTE PRODUCED BY THE CASE

The partitioning and transmutation case produces the following quantities of wastes, which are likely to require emplacement in a geologic repository:

- Between 9,200 and 41,200 waste packages of high-level radioactive waste from the pyroprocessing of spent nuclear fuel from light-water reactors (Section 5.3.1).
- Between 61,400 and 93,000 storage casks (or 34,400-52,100 metric tons) of uranium extracted from the spent nuclear fuel discharged from light-water reactors (Section 5.3.2).
- Between 400 and 4,900 waste packages of high-level radioactive waste from the pyroprocessing of advanced liquid-metal reactor spent nuclear fuel (Section 5.3.3).
- A total of 74,900 metric tons of spent nuclear fuel from light-water reactors.

The wide range in the values reflects differences in assumptions among various studies as to how compact the waste forms can be made, and how the waste forms may be emplaced in storage containers. ~~Differences are not attributed to uncertainties over process development. The remainder of this section explains how these results were obtained.~~ Appendix B explains how these results were obtained.

Waste packages of various dimensions have been suggested to hold the wastes resulting from pyroprocessing of both light-water reactor and advanced liquid-metal reactor spent nuclear fuels. The capacities of these packages range from 18 to 39 cubic feet of waste. (By comparison, the waste canisters for high-level radioactive waste described in Section 4.1 would each hold about 31 cubic feet of waste.)

Table 5-1 summarizes the quantities of all waste materials (including spent nuclear fuel, high-level radioactive waste, and reprocessed uranium) for the partitioning and transmutation case through 2030.

5.3.1 Pyroprocessing of Light-Water Reactor Spent Nuclear Fuel

~~It is assumed in this case that the pyroprocessing of light water reactor spent nuclear fuel uses the salt transport process.[8,9,10] This process results in the extraction of uranium and transuranic elements — chiefly plutonium, americium, curium, and neptunium — in a metallic form, which may be used to make new fuel. Table 5-1 lists wastes, produced through this process, their estimated quantities, and assumed matrix materials. A separate uranium metal waste stream is also produced which may, or may not, be a waste stream requiring repository disposal (Section 5.3.2).~~

Table 5-1

Repository Waste Produced by the Pyroprocessing of Light Water Reactor Spent Nuclear Fuel

Type of Waste	Matrix	Waste Packages per 1,000 Metric Tons of Light Water Reactor Spent Nuclear Fuel Reprocessed
Metal wastes, including fuel and assembly hardware, transport metal, electrorefiner metal, and other process wastes such as anode baskets, crucibles, fume traps, and other wastes.	Copper or hardware may be packaged separately with no other matrix material.	90-244
Salt wastes, including reduction salt, transport salt, and electrorefiner salt.	Zeolite	165-494
Gases (primarily tritium, carbon-14, and iodine-129).	Molecular sieves or AgI	0-13
Total number of waste packages per 1,000 metric tons of heavy metal		255-751
Total number (rounded to nearest 100) of waste packages for 36,200-54,800 metric tons of heavy metal[a]		9,200-41,200[b]

Source: References 8 and 12.

(a) Estimated quantity of light water reactor spent fuel that would need to be reprocessed to supply all fuel requirements for advanced liquid metal reactors by 2030.

(b) This case also produces 21 to 79 waste packages of noble gases (primarily krypton-85 and xenon-131) per 100 metric tons of spent nuclear fuel processed. These are not included in the total in this table because they are in a compressed gas form, which is not suitable for repository disposal.

Table 5-1

Spent Nuclear Fuel and High-Level Radioactive Waste Produced in the Partitioning and Transmutation Case

Type of Waste	Amount of Waste	
	Metric Tons of Heavy Metal	Packages or Casks
High-level radioactive waste from pyroprocessing of light-water reactor spent nuclear fuel	--	9,200-41,200 packages
Reprocessed uranium extracted from light-water reactor spent-nuclear fuel (uranium storage casks)[a]	--	61,400-93,000 casks
High-level radioactive waste resulting from the pyroprocessing of advanced liquid-metal reactor spent nuclear fuel	--	400-4,900 packages
Spent nuclear fuel produced by light-water reactors and not reprocessed	55,700-74,900	--

(a) This table lists reprocessed uranium as a radioactive waste since its ultimate disposition is unknown.

The transuranic fuel requirements of advanced liquid-metal reactors consist of (1) the initial, or startup, fuel load, which is usually assumed to include the first two core reloads; and (2) the makeup fuel needed annually to replace the transuranic elements consumed by fission. These fuel requirements can be expressed in terms of the amount of light-water reactor spent nuclear fuel that must be reprocessed to supply the necessary transuranic material. Each metric ton of light-water reactor spent nuclear fuel contains about 9.72 kilograms of transuranics.[11] Each advanced liquid-metal reactor could require between 1,480 and 2,449 metric tons of light-water reactor spent nuclear fuel for an initial loading and two reloads, and between 47.3 and 48.4 metric tons per year thereafter.[12,13] The ranges in these data are because of differences in the assumed reactor design, which has not yet been fully effective for actinide burning. Other values pertaining to the fuel requirements of advanced liquid-metal reactors stated in the published literature fall within these ranges.

By 2030 in this case, between 36,200 and 54,800 metric tons of light-water reactor spent nuclear fuel undergo pyroprocessing to supply the startup fuel for 19 new reactors and makeup fuel for 171 reactor-years. (Assuming that one new reactor per year begins operation from 2012 to 2030, advanced liquid-metal reactors will accumulate a total of 171 reactor-years by 2030.)

The volumes of high-level radioactive waste resulting from the pyroprocessing of between 36,200 and 54,800 metric tons of light-water reactor spent nuclear fuel have been calculated for this case by scaling data from two studies[8,14] to obtain the expected volumes of high-level radioactive wastes from each 1,000 metric tons of light-water reactor spent nuclear fuel reprocessed. Table 5-1 lists the resulting number of containers and the total quantity of waste generated by 2030. In this case, pyroprocessing of light-water reactor spent nuclear fuel through 2030 will produce between 9,200 and 41,200 packages of high-level radioactive waste. The number of waste packages will vary with the following parameters:

1. Burnup level of the light-water reactor spent nuclear fuel to be reprocessed: a typical value of 33,000 megawatt-days per metric ton is used in much of the technical literature, but some studies indicate that higher burnup rates may be more likely in the future.[15]

2. Actinide recovery rates for pyroprocessing: rates that range from 99.9 percent to 99.999 percent are given by the technical literature.

3. Matrix or waste form in which gaseous fission products are contained for disposal.

4. Sizes and types of packages used to contain the wastes produced by the pyroprocessing.

The values in Table 5-1 encompass various waste compositions and waste package designs suggested by the two studies.[8,12] The various wastes may be either packaged separately or combined into "salt waste" and "metal waste." The sizes of waste packages suggested for these wastes range from 0.53 cubic meters (500 centimeters high and 40 centimeters in diameter) to

~~1.27 cubic meters (450 centimeters high and 60 centimeters in diameter). Except for the combined salt wastes in the 1.27 cubic meter package, each waste package considered in Table 5-1 would produce less than 2,000 watts of heat. The salt wastes will produce about 3,900 watts of heat per package. Noble gases, primarily the fission products krypton 85 and xenon 131, would be compressed to several hundred atmospheres and contained in high-pressure steel cylinders. Each package of this waste contains 72 cylinders and produces about 300 watts of heat.~~

~~The ultimate disposition of the noble gas wastes has not been determined. Some researchers suggest placing these short lived radionuclides in a surface storage facility until they have decayed to negligible levels.[8,9] Others suggest the disposal of these wastes in another repository specifically designed for them.[12] However, existing regulations prohibit the repository disposal of compressed gas waste forms. Therefore, estimated quantities of compressed gas waste — indicated in notes to Tables 5-1 and 5-2 for completeness — are not included in the total wastes volumes shown.~~

The pyroprocessing of light-water reactor spent nuclear fuel results in the extraction of uranium and transuranic elements (chiefly plutonium, americium, curium, and neptunium) in a metallic form which may be used to make new fuel for advanced liquid-metal reactors. Pyroprocessing also yields uranium metal, which may or may not need to be treated as a waste requiring repository disposal (Section 5.3.2).

The transuranic fuel requirements of advanced liquid-metal reactors consist of (1) the initial, or startup, fuel load, which is usually assumed to include the first two core reloads; and (2) the makeup fuel needed annually to replace the transuranic elements consumed by fission. These fuel requirements can be expressed in terms of the amount of light-water reactor spent nuclear fuel that must be reprocessed to supply the necessary transuranic material.

By 2030, between 36,200 and 54,800 metric tons of light-water reactor spent nuclear fuel will need to undergo pyroprocessing to supply the startup and makeup fuel for the 19 advanced liquid-metal reactors assumed to be operating at that time. The pyroprocessing of this spent nuclear fuel will produce between 9,200 and 41,200 packages of high-level radioactive waste. (The derivation of these figures is explained in Appendix B.) The range in the numbers of waste packages reflects various waste compositions and waste package designs, not all of which have been thoroughly evaluated for repository disposal. Pyroprocessing wastes may be either packaged separately or combined into "salt waste" and "metal waste." Waste compositions and containers are described in more detail in Appendix B.

5.3.2 Uranium Produced by the Pyroprocessing of Light-Water Reactor Spent Nuclear Fuel

~~In the partitioning and transmutation case, between 34,400 and 52,100 metric tons of uranium are produced by the pyroprocessing of spent nuclear fuel from light water reactors in order to supply initial and makeup actinide fuel loads for new advanced liquid metal reactors. This uranium could occupy between 61,400 and 93,000 storage casks, each holding 560 kilograms~~

~~of uranium dioxide. The remainder of this section describes how these values were obtained.~~

~~Spent light water reactor fuel is about 96 percent uranium by mass. After recovering the uranium by pyroprocessing, only about 1 percent would be needed to produce fuel for advanced liquid metal reactors.[16]~~

~~Most of the reprocessed uranium would have no direct use for the advanced liquid metal reactors assumed in this case. There are several options for managing this reprocessed uranium. One option, the reenrichment and recycling of the reprocessed uranium as light water reactor fuel, might be limited by the multicycle buildup of uranium 236, which acts to inhibit nuclear fissioning within the reactor. Uranium 236 might be extracted more efficiently through advanced enrichment technologies, but this could have other undesirable effects on uranium enrichment waste streams.[13,14] Although most studies to date assume the long-term storage and eventual reuse of the reprocessed uranium, a second option—disposal in a geologic repository—may ultimately be required.~~

~~In Section 5.3.1, it was stated that between 36,200 and 54,800 metric tons of light water reactor spent nuclear fuel would be reprocessed by 2030 to meet the need for advanced liquid metal reactor fuel. If this light water reactor spent nuclear fuel contains 96 percent uranium and, if 1 percent of the reprocessed uranium is used to produce new fuel for advanced liquid metal reactors, then between 34,400 and 52,100 metric tons of reprocessed uranium would remain for reuse or disposal.~~

~~The forms in which reprocessed uranium would be disposed have not been extensively investigated. The authors of a recent study postulate its disposal as uranium dioxide in stainless steel storage casks, each capable of holding 560 kilograms of uranium.[13] Between 61,400 and 93,000 of those casks would be needed to dispose of the uranium generated in this case. These values, however, are tentative; the actual number of uranium storage containers may vary greatly, depending on the container size and type.~~

Light-water reactor spent fuel is about 96 percent uranium by mass, only about one percent of which would be used in the production of fuel for advanced liquid-metal reactors.[15] In the partitioning and transmutation case, between 36,200 and 54,800 metric tons of light-water reactor spent nuclear fuel would be reprocessed by 2030 to meet the need for advanced liquid-metal reactor fuel (Section 5.3.1). If this light-water reactor spent nuclear fuel contains 96 percent uranium, and if one percent of the reprocessed uranium is used to produce new fuel for advanced liquid-metal reactors, then between 34,400 and 52,100 metric tons of reprocessed uranium would remain for reuse or disposal.

Most of the reprocessed uranium would have no direct use for the advanced liquid-metal reactors assumed in this case. There are several options for managing this reprocessed uranium. One

Table 5-2

Waste Resulting From the Pyroprocessing of Spent Nuclear Fuel From Advanced Liquid Metal Reactors

Type of Waste	Matrix	Waste Packages per 100 Gigawatt (electric) years
Electrorefining salt	Zeolite	153-1,855
Fuel hardware (cladding hulls) and electrorefining metal	Copper	92-727
Total waste packages per 100 gigawatt (electric) years		245-2,582
Total waste packages (rounded to nearest 100) for 167-191 gigawatt (electric) years[a]		400-4,900[b,c]

Source: References 9, 12, and 17.

(a) Expected power production from all advanced liquid metal reactors by 2030.

(b) Fifty three waste packages of compressed noble gases (primarily krypton 85 and xenon 131) per 100 gigawatt (electric) years are also produced by the pyroprocessing of advanced liquid metal reactor spent nuclear fuel. These are not included in the totals because the compressed gas waste form is unsuitable for repository disposal.

(c) This figure is used in the scenario for advanced liquid metal reactors described in the next section.

option, the reenrichment and recycling of the reprocessed uranium as light-water reactor fuel, might be limited by the multicycle buildup of uranium-236, which acts to inhibit nuclear fission within the reactor. Uranium-236 might be extracted more efficiently through advanced enrichment technologies, but this could have other undesirable effects on uranium-enrichment waste streams.[15,16] Although most studies to date assume the long-term storage and eventual reuse of the reprocessed uranium, a second option - disposal in a geologic repository - may ultimately be required.

The forms in which reprocessed uranium would be disposed have not been extensively investigated. The authors of a recent study postulate its disposal as uranium dioxide in stainless steel storage casks, each capable of holding 560 kilograms of uranium.[13] Between 61,400 and 93,000 such casks would be needed to dispose of the uranium generated in this case. These values, however, are tentative; the actual number of uranium storage containers may vary greatly, depending on the container size and type.

5.3.3 Waste Produced by Pyroprocessing Spent Nuclear Fuel From Advanced Liquid-Metal Reactors

~~Even though pyroprocessing of spent nuclear fuel from advanced liquid metal reactors is still under development, enough information is available to describe the resulting types and quantities of waste. In the partitioning and transmutation case, between 400 and 4,900 packages of radioactive waste requiring repository disposal are produced by the pyroprocessing of spent nuclear fuel from advanced liquid metal reactors.~~

~~The quantities and assumed matrix materials for these wastes are listed in Table 5-2. Although the indicated matrix materials have been cited in recent studies,[10,17,18,19] the best form for pyroprocessing each waste has not been determined. In particular, an optimum way to contain and immobilize the pyroprocessing salt waste remains an area of active research. A compacted zeolite waste for the salt waste is assumed in this analysis.~~

~~The number of high-level radioactive waste packages produced during the operational life of an advanced liquid metal reactor depends on several factors:~~

1. ~~The rate of fuel throughput for the reactor, which in turn depends on the design and operational parameters of the reactor.~~

2. ~~The actinide recovery rate for the pyrochemical process. (Values in the range of 99.9 to 99.999 percent are stated in the published literature.)~~

3. ~~Matrix or waste form in which each waste stream is contained for disposal and the extent to which waste streams are combined in common matrices.~~

4. ~~The size, type, and thermal output of waste packages.~~

It is assumed in this case that all resulting wastes from the pyroprocessing of advanced liquid-metal spent nuclear fuel are disposed of without further partitioning and transmutation of specific nuclides.

If advanced liquid-metal reactor capacity factors vary from 0.7 to 0.8, then each reactor of the reference design will generate between 977 and 1,116 megawatt (electric) years of power each year of operation. By 2030, the 19 reactors deployed in this case will have operated a total of 171 years, producing between 167 and 191 gigawatt (electric) years of power.

The quantities of high level radioactive waste from pyroprocessing have been derived from the results of three recent studies.[9,12,17] Table 5-2 lists these quantities in terms of the number of waste packages per 100 gigawatt (electric) years of power production. The expected total quantities of high-level radioactive waste pyroprocessing were calculated by scaling these data to the values given above for the expected power production by 2030.

The number of waste packages due to pyroprocessing advanced liquid-metal reactor spent nuclear fuel may be reduced by up to 32 percent, according to the results of one study,[20] by altering the waste package dimensions to increase the heat output of each package up to acceptable limits. The number of waste packages listed in Table 5-2 are calculated based on common package dimensions used in the studies cited; all result in a per-package thermal output that is well within the accepted limits.

Even though pyroprocessing of spent nuclear fuel from advanced liquid-metal reactors is still under development, enough information is available to describe the resulting wastes and develop preliminary estimates of waste quantities. In the partitioning and transmutation case, between 400 and 4,900 packages of radioactive waste requiring repository disposal are produced by the pyroprocessing of spent nuclear fuel from advanced liquid-metal reactors. This estimate is based on the range of package dimensions used in recent studies. The suitability of all such waste packages for repository disposal has not been thoroughly evaluated.

Wastes resulting from the pyroprocessing of advanced liquid-metal reactors are described in Appendix B, together with an explanation of how waste quantities were calculated.

5.3.4 Spent Nuclear Fuel Consumed in the Case

The partitioning and transmutation case involves the pyroprocessing of light-water reactor spent nuclear fuel, thereby recovering for reuse materials that would otherwise be emplaced in a geologic repository. In this case, between 36,200 and 54,800 metric tons of spent nuclear fuel from reactors are consumed by pyroprocessing (Table 5-3) and ultimately converted to energy, high-level radioactive waste, and uranium.

The partitioning and transmutation case would also result in the generation of electrical power by advanced liquid-metal reactors. For the upper reference case without partitioning and transmutation, this power would be provided by other nuclear sources, such as light-water reactors. Thus the deployment of advanced liquid metal reactors would eliminate the generation of wastes from light water reactors of equivalent capacity. As a result, quantitative differences between the waste streams of partitioning and transmutation and the waste streams produced in other cases must be assessed in terms of equal energy production.[9] The partitioning and transmutation case would result in the net generation of between 167 and 191 gigawatt (electric) years of power by 2030. If this power were generated by light water reactors rather than by advanced liquid metal reactors, then the light water reactors would produce 28 metric tons of spent nuclear fuel per 1,000 megawatt (electric) years,[9] or a total of between 4,700 and 5,300 metric tons of spent nuclear fuel through 2030. Table 5-3 describes the reduction in spent nuclear fuel inventories through 2030 in the partitioning and transmutation case.

Table 5-4 summarizes the quantities of spent nuclear fuel and high-level radioactive waste for the partitioning and transmutation case through 2030.

The partitioning and transmutation case involves the pyroprocessing of light-water reactor spent nuclear fuel, thereby recovering for reuse materials that would otherwise be emplaced in a geologic repository. In this case, between 36,200 and 54,800 metric tons of spent nuclear fuel from light-water reactors undergo pyroprocessing (Section 5.3.1) and are ultimately converted to energy, high-level radioactive waste, and uranium. This represents a net reduction in spent fuel inventories.

The partitioning and transmutation case would result in the generation of electrical power by advanced liquid-metal reactors instead of other nuclear sources such as light-water reactors, as in the upper reference case. The deployment of advanced liquid-metal reactors would thus eliminate the generation of spent fuel from light-water reactors of equivalent capacity. This quantity of light-water reactor spent fuel - calculated here as 4,700 to 5,300 metric tons (see Appendix B) would therefore be prevented from entering the spent fuel inventory.

These reductions in spent nuclear fuel inventories are tabulated and applied as changes to the upper reference case. (See Appendix B.) The net result is a total of 55,700 to 74,900 metric tons of spent fuel produced in the partitioning and transmutation case, compared to 115,800 metric tons of spent fuel in the upper reference case. As noted previously, electrical power generation is the same in the two cases.

Table 5-3

Spent Nuclear Fuel Produced Through 2030 in the Partitioning and Transmutation Case

Type of Waste	Light Water Reactor Spent Nuclear Fuel Inventory Metric Tons of Heavy Metal
Light water reactor spent nuclear fuel reprocessed to produce new advanced liquid metal reactor fuel (removed from the spent nuclear fuel inventory)	(-)36,200 - (-)54,800
Light water reactor spent nuclear fuel needed to produce power equal to that produced by advanced liquid metal reactors (prevented from entering the spent nuclear fuel inventory)	(-)4,700 - (-)5,300
Subtotal	(-)40,900[a] - (-)60,100
Spent nuclear fuel produced in the upper reference case (Sec. 3)	(+)115,800
Total spent nuclear fuel produced by the partitioning and transmutation case (and assumed in the advanced liquid metal reactor scenario)	(+)55,700 - (+)74,900

(a) Subtracted from the amount of spent nuclear fuel produced in the upper reference case (i.e., 115,800 metric tons of spent nuclear fuel) to obtain amount produced in the partitioning and transmutation case.

Table 5-4

Spent Nuclear Fuel and High-Level Radioactive Waste Produced in the Partitioning and Transmutation Case

Type of Waste	Amount of Waste	
	Metric Tons of Heavy Metal	Packages or Casks
High level radioactive waste from pyroprocessing of light water reactor spent nuclear fuel	-	9,200-41,200 packages
Reprocessed uranium extracted from light water reactor spent nuclear fuel (uranium storage casks)[a]	-	61,400-93,000 casks
High level radioactive waste resulting from the pyroprocessing of advanced liquid metal reactor spent nuclear fuel	-	400-4,900 packages
Spent nuclear fuel produced by light water reactors and not reprocessed	55,700-74,900	-

(a) This table lists reprocessed uranium as a radioactive waste since its ultimate disposition is unknown.

6. SCENARIO ANALYSIS

In this section, three scenarios are developed, two of which involve new nuclear power plants (Section 6.1). Each scenario consists of the assumptions made earlier (Sections 3 through 5) in the cases that produce high-level radioactive waste and spent nuclear fuel. The reference scenario is developed and compared with the two scenarios in which new plants are constructed after October 24, 1992. These two scenarios are

1. the **Upper-Bound Scenario** in which new advanced light-water reactors start operating and existing light-water reactors continue to operate, and

2. the **Advanced Liquid-Metal Reactor Scenario** in which these and advanced light-water reactors are constructed after October 24, 1992. Existing light-water reactors continue to operate.

The amount of nuclear waste generated by each scenario is determined by the cases in each scenario. The assumptions made in the cases are described in Sections 3 through 5.

Section 6.1 describes the development of scenarios and the nuclear wastes produced and compares the wastes produced in the three scenarios. Next, the adequacy of current programs and plans for the management of the high-level radioactive waste and spent nuclear fuel produced in the scenarios is evaluated (Section 6.2). Because the scenarios could have been composed of other assumptions on waste production, a discussion of those alternatives is provided in Section 6.3. Section 7 describes nuclear wastes that are not considered in the scenarios but may require geologic disposal.

6.1 SCENARIO DEVELOPMENT

The critical assumptions of the three scenarios and the wastes produced in them through 2030 are shown in Figure 6-1 and outlined in Table 6-1 and described in detail in the next three subsections.

6.1.1 Reference Scenario

The reference scenario assumes that no new commercial nuclear power plants begin to operate after October 24, 1992. (In this report, new plants are defined as commercial nuclear power plants whose construction began after that date.) Thus commercial nuclear power is generated by existing light-water reactors. Furthermore, none of these plants retire before the end of their 40-year licenses, and none renew their licenses for an additional 20 years. In addition, high-level radioactive waste in the underground tanks at four sites (produced by pre-1992 reprocessing of spent nuclear fuel and other materials) is treated and stored in canisters pending permanent disposal in a geologic repository, including 10,000 canisters from the single-shell tanks at the Hanford site.

Table 6-1

Spent Nuclear Fuel and High-Level Radioactive Waste Produced by Scenarios

Source of Waste	Reference Scenario	Upper-Bound Scenario	Advanced Liquid-Metal Reactor Scenario
		Spent Nuclear Fuel	
Total spent nuclear fuel generated by light-water reactors	**85,700 metric tons** (no-new-orders case)	**115,800 metric tons** (upper reference case)	**74,900 metric tons** (P-T case)
		High-Level Radioactive Waste	
High-level radioactive waste in underground tanks at four sites	23,900 canisters (medium-generation case)	48,900 canisters (high-generation case)	48,900 canisters (high-generation case)
Pyroprocessing of light-water reactor spent nuclear fuel to prepare fuel for new advanced liquid-metal reactors	Not applicable	Not applicable	41,200 packages[a] (P-T case)
Pyroprocessing of spent fuel from actinide-burning advanced liquid-metal reactors to prepare fuel for the same	Not applicable	Not applicable	4,900 packages[b] (P-T case)
Total high-level radioactive waste	**23,900 canisters**	**48,900 canisters**	**95,000 packages and canisters**

Note: Metric tons in this document means metric tons of heavy metal (spent nuclear fuel). All canisters of high-level radioactive waste in the high-generation case and medium-generation case are the same size; see Section 4 for further information. Packages and casks of high-level radioactive waste in the partitioning and transmutation case are of other sizes; see Section 5 for details on their designs and sizes.
(a) Upper value in range reported in Section 5 (9,200 to 41,200 packages).
(b) Upper value in range reported in Section 5 (400 to 4,900 packages).

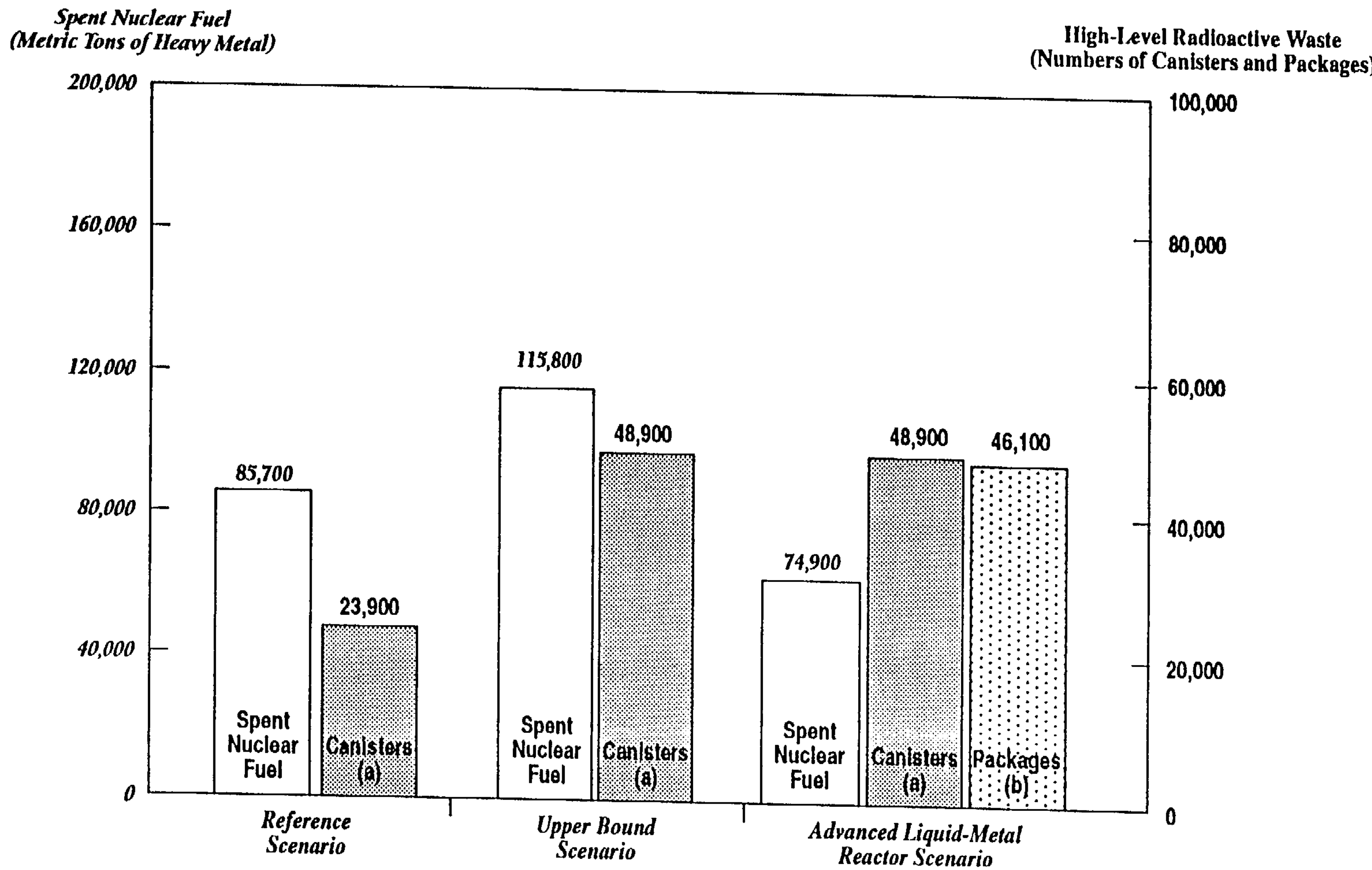


Figure 6-1
Spent nuclear fuel and high-level radioactive waste generated by three scenarios through 2030.

Notes:

(a) Canisters are from solidifying existing high-level radioactive waste described in Section 4.

(b) Packages are from reprocessing spent nuclear fuel described in Section 5. The 46,100 packages are the upper value in the range reported in Section 5 (9,600 to 46,100). The Advanced Liquid-Metal Reactor Scenario also generates between 61,400 and 93,000 reprocessed uranium storage casks. It is not shown on this figure but is discussed in Section 5.

The amounts of repository-bound waste produced through 2030 in this scenario were determined by adding the amounts produced by the no-new-orders case for spent nuclear fuel and the medium-generation case for high-level radioactive waste. The scenario produces:

1. ***Spent nuclear fuel:*** 87,500 metric tons from existing light-water reactors.

2. ***High-level radioactive waste:*** 23,900 canisters from four sites.

6.1.2 Upper-Bound Scenario

In this scenario, a number of commercial nuclear power plants with advanced light-water reactors are deployed. In addition, the licenses of 70 percent of the existing plants, which have light-water reactors, are renewed for 20 years. High-level radioactive waste produced by reprocessing primarily defense-related spent nuclear fuel at four sites is treated, placed in canisters, and stored pending permanent disposal, with 35,000 canisters coming from the single-shell tanks at the Hanford site.

The amounts of nuclear waste produced in this scenario were determined by adding the amounts generated through 2030 in the upper reference case for spent nuclear fuel and in the high-generation case for high-level radioactive waste:

1. ***Spent nuclear fuel:*** 115,800 metric tons from existing and new advanced light-water reactors.

2. ***High-level radioactive waste:*** 48,900 canisters from four sites.

6.1.3 Advanced Liquid-Metal Reactor Scenario

In the third scenario, 19 new nuclear power plants with actinide-burning advanced liquid-metal reactors are deployed between 2012 and 2030. To produce fuel for the new reactors, spent nuclear fuel from existing light-water reactors and advanced light-water reactors undergoes pyroprocessing, producing high-level radioactive waste. (Spent nuclear fuel is also produced in this scenario.) As in the upper-bound scenario, canisters of high-level radioactive waste from four sites are stored pending disposal in a geologic repository, including 35,000 canisters from the single-shell tanks at the Hanford site.

The amounts of high-level radioactive waste produced by this scenario were determined by adding those generated through 2030 in the partitioning and transmutation case (Section 5) and the high-generation case (Section 4). The partitioning and transmutation case consists of all assumptions of the upper reference case for spent nuclear fuel plus assumptions about the operation of the new actinide-burning advanced liquid-metal reactors. The scenario produces:

1. *Spent nuclear fuel:* 74,900 metric tons discharged from light-water reactors (existing and new) not consumed by pyroprocessing.

2. *High-level radioactive waste:*

   a. 48,900 canisters from four sites,
   b. 9,200 to 41,200 waste packages produced by the pyroprocessing of spent nuclear fuel from existing and new advanced light-water reactors, and
   c. 400 to 4,900 waste packages produced by the pyroprocessing of spent nuclear fuel from the new actinide-burning advanced liquid-metal reactors.

6.1.4 Comparison of Waste Production by Scenario

Figure 6-1 shows the amounts of all types of nuclear wastes produced by the three scenarios through 2030. In comparison with the reference scenario,

1. The upper-bound scenario with existing and new light-water reactors produces 30,100 metric tons more of spent nuclear fuel and 25,000 more canisters of high-level radioactive waste.

2. The advanced liquid-metal reactors scenario produces 10,800 fewer metric tons of spent nuclear fuel and additional high-level radioactive waste (up to 46,100 waste packages and 25,000 canisters).

Through 2030, the use of advanced liquid-metal reactors results in 40,900 fewer metric tons of spent nuclear fuel compared with the upper-bound scenario. In comparison with that scenario, the addition also results in more high-level radioactive waste, which consists of up to 46,100 waste packages from the pyroprocessing of spent nuclear fuel. The scenario produces the least amount of spent nuclear fuel from existing and new light-water reactors owing to the pyroprocessing of that spent fuel to prepare fuel for new actinide-burning advanced liquid-metal reactors.

6.2 SCENARIO ANALYSIS

For the purpose of this analysis, we assume current program and plans are adequate for the reference scenario.

The upper-bound and advanced liquid-metal reactor scenarios have been developed to answer this question: Would the current programs and plans for the management of nuclear waste (as mandated by the Nuclear Waste Policy Act of 1982) be adequate for the permanent disposal of the volumes and categories of waste produced by the new nuclear power plants assumed in the scenarios?

To answer this question, we focused our analysis on these areas:

- The need for a second repository (Section 6.2.1).
- Interim waste storage (Section 6.2.2).
- Waste transportation (Section 6.2.3).
- Waste acceptance (Section 6.2.4).
- Costs of and funding for the program (Section 6.2.5).
- Regulatory framework of the program (Section 6.2.6).
- Decision to emplace defense waste and commercial waste in the same repository (Section 6.2.7).

Our analysis is conducted at a programmatic, rather than a detailed technical, level. Technical aspects of the program such as waste emplacement capacities and schedules, facility designs, and facility cost estimates did not need to be evaluated to reach conclusions that satisfy the purpose of this report.

6.2.1 The Need For a Second Repository

The amount of waste generated in all three scenarios: the reference scenario, the upper-bound scenario, and the advanced liquid-metal reactor scenario; exceeds the 70,000-metric-ton constraint on a first repository described in Section A.1.8. Therefore, if any of these scenarios were realized, a second repository would be required if the 70,000-metric-ton constraint remained in place. However, the focus of this evaluation is on the timing of determining the need for a second repository.

Current programs and plans require that the Department of Energy evaluate the need for a second repository between 2007 and 2010 (Section A.1.7). The timing of this decision is adequate to manage the waste that would be generated in the upper-bound and advanced liquid-metal reactor scenarios. Figure 6-2 shows an estimated schedule for waste emplacement at first and second repositories in relation to the operation of the assumed new nuclear power plants and the existing plants whose licenses are renewed. Note the overlap of periods for waste emplacement and waste generation. This indicates that waste emplacement will be possible when it is required.

If the decision to build a second repository is made by 2010, it is assumed that waste would be emplaced by 2040. This assumption is speculative given that a first repository has not yet been developed and there is no schedule for a second repository program. ~~However, the Department has considerable experience with repository siting activities and site characterization.~~ The schedule for a second repository is based on following a process similar to the first repository, with a similar amount of time allotted for each major milestone. Although not assumed, there may be some time savings because of experience gained during first repository development.

The Office of Civilian Radioactive Waste Management is proceeding with site characterization activities on the basis that 63,000 metric tons of spent nuclear fuel and 13,500 canisters of high-level radioactive waste would be emplaced in a first repository. This is derived from the 70,000-metric-ton constraint described in Section A.1.8. Since the upper-bound scenario generates 115,800 metric tons of spent nuclear fuel and 48,900 canisters of high-level radioactive waste (through 2030), 52,800 metric tons of spent nuclear fuel and 35,400 canisters of high-level radioactive waste would require disposal in either a second repository or in the first repository if the 70,000-metric-ton constraint is removed.

By 2030, the advanced liquid-metal reactor scenario generates 74,900 metric tons of spent nuclear fuel and from 9,600 to 46,100 packages of high-level radioactive waste from pyroprocessing and 48,900 canisters of high-level radioactive waste from defense-related processing. Based on the planned waste emplacement in a first repository, 11,900 metric tons of spent nuclear fuel and between 45,000 and 81,500 canisters and packages of high-level radioactive waste would require disposal in either a second repository or in the first repository if the 70,000-metric-ton constraint is lifted.

The planned emplacement of waste in a first repository is based on the statutory 70,000-metric-ton constraint, not on technical limitations. As noted in Section A.2.2, the actual capacity is based on at least three major technical factors: (1) the available area, (2) the thermal-mechanical characteristics of the rock, and (3) the heat-generating characteristics of the waste at the time of their emplacement. This information is needed to make a decision concerning the need for a second repository. Since the first repository site is now being investigated and its design is in an early stage of development, these factors are not known. They will become known when and if the Department submits a license application and begins repository construction. This coincides with making an informed decision on the need for a second repository between 2007 and 2010 and timely completion of site-characterization activities.

An important design measure related to repository capacity is thermal-loading which is the heat output of the emplaced waste, measured in kilowatts, per unit area of the repository, measured in acres. The selection of a thermal-loading scenario for disposal at Yucca Mountain will not be based on capacity requirements. Rather, the choice will be decided based on the optimal isolation of wastes. The site characterization plan conceptual design for Yucca Mountain assumed a thermal loading of 57 kilowatts per acre. This thermal loading resulted in a projected capacity of 77,000 metric tons when combined with other assumptions regarding waste emplacement area and waste characteristics. Higher thermal loading values may allow more waste to be emplaced, but a conclusive estimate cannot be made until the thermal-loading options currently being investigated (20-140 kilowatts per acre) are narrowed. The Department expects to narrow thermal-loading options by early 1994, and select a single value before 2001.

Other important factors in deciding on a second repository are the amounts and types of waste that will need to be emplaced in it. The scenarios in this report are based on many assumptions regarding future nuclear-generating capacity, types of reactors, and methods of waste treatment. Although all of the scenarios developed in this report, including the reference scenario, generate more than 70,000 metric tons of spent nuclear fuel, it would not be prudent to make a decision on the need for a second repository based on these assumptions. The Department of Energy will be in a better position to determine the need for a second geologic repository between 2007 and 2010.

Two key assumptions made in this analysis and illustrated in Figure 6-2 are that: (1)the Department will have enough information to support a decision on the need for a second repository by 2010, and (2)a second repository can be constructed in 30 years if it is needed. A recent report by the General Accounting Office questioned the Department's schedule for completing site characterization and submitting a license application for a first repository by 2001, assuming the site is found suitable. While delays in completing site characterization and submitting a license application are possible, the Department remains confident that information contributing to a decision on the need for a second repository will be gathered well before the 2007 to 2010 time period. And information gained from site characterization will be important in deciding on the need for a second repository.

Regarding the second assumption, it is speculative to assume that a second repository could be constructed within 30 years since the Department has not successfully completed the construction of a first repository. However, as noted in Figure 6-2, even a 20-year delay in construction of a second repository would not significantly affect the ability to manage waste being considered in this report. New nuclear power plants would be phased in gradually beginning in 2010. Even if a second repository is not available until 2060, it would be well within the initial period of interim storage for the first of the new nuclear plants.

6.2.2 Interim Storage

For this report, interim storage refers to either at-reactor storage, storage at a monitored retrievable storage facility or at a Federal site. Because no volunteer host has been selected for the monitored retrievable storage facility, the Federal government is considering adoption of a multi-purpose canister that would allow utilities to store their spent nuclear fuel at the reactor site, with eventual transfer of the multi-purpose canister to the Federal government when operations begin either at the monitored retrievable storage facility or the geologic repository. The Federal siting option, identified by former Secretary of Energy Admiral James Watkins, is not now being actively pursued by the Department. Regardless of the method used for interim storage of spent nuclear fuel prior to placement into the repository, the capability exists within industry, and within the Federal government, to provide adequate and safe storage of spent nuclear fuel.

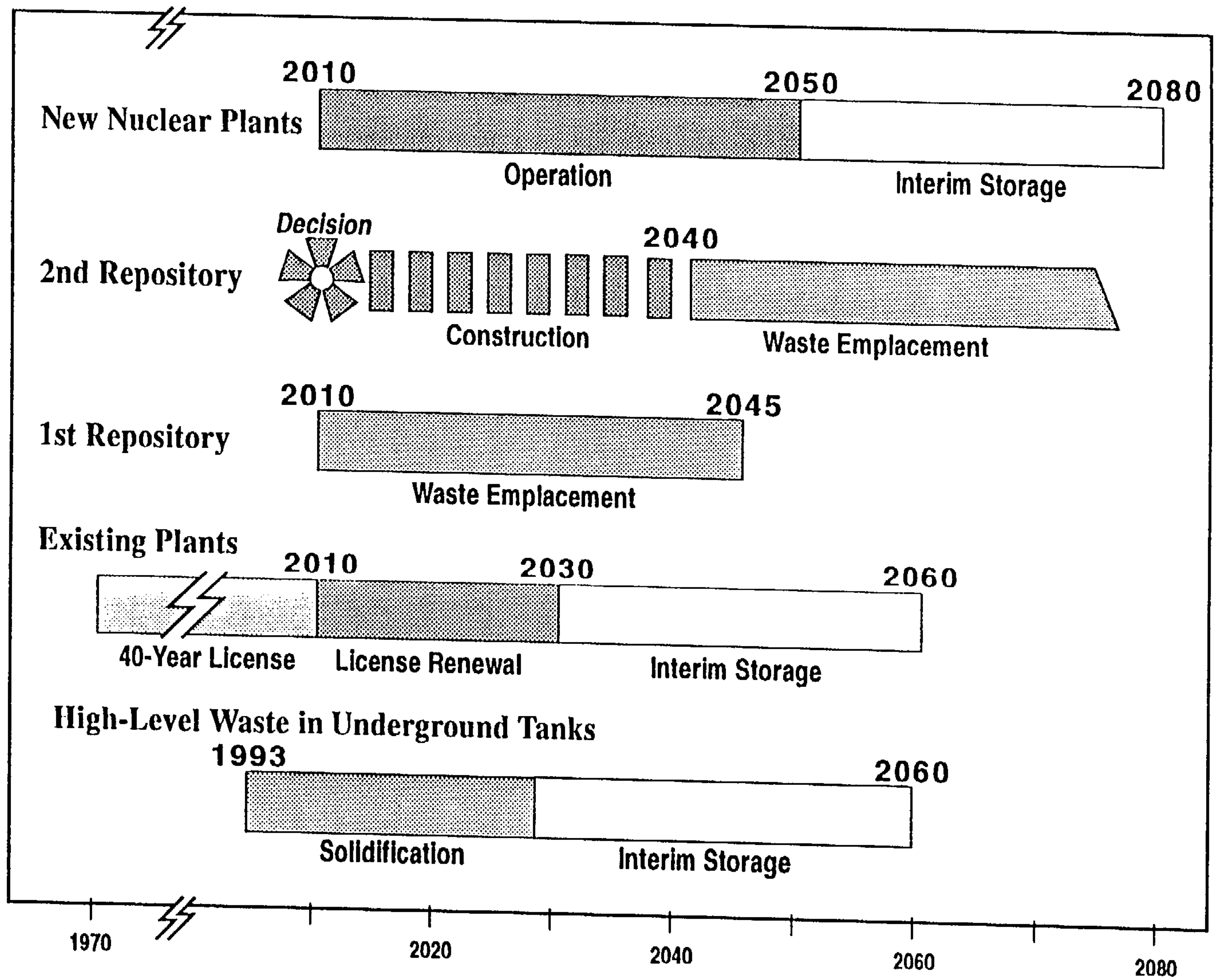


Figure 6-2
Significant Events Discussed in the Analyses of Scenarios

High-level radioactive waste comes from underground tanks at four sites and from the operation of new advanced liquid-metal reactors (2012-2052). Both existing and new reactors generate spent nuclear fuel. New advanced light-water reactors operate 2006-2046. Scenarios with these new plants also include existing light-water reactors which operate through at least 2010 without license renewal. Only 70 percent of existing light-water reactors have their licenses renewed for 20 years in the two scenarios with new reactors. The schedules for first and second repository development are estimates only and will not be finalized until site characterization is completed for the first repository.

In spite of the current difficulties in finding a site for a monitored retrievable storage facility, programs and plans regarding interim storage are adequate for managing waste generated in both scenarios with new nuclear power plants. In Figure 6-2, we assume that interim storage of spent nuclear fuel would be available for 30 years beyond both the 40-year operation of new nuclear power plants and the 20-year license renewal period for existing plants. Similarly, we assume that the interim storage of high-level radioactive waste canisters and packages would be possible until they can be emplaced in a repository. Interim storage could be provided at the sites where the spent nuclear fuel and high-level radioactive waste is produced or at other sites.

For the interim storage of spent nuclear fuel at a monitored retrievable storage facility, the Office of Civilian Radioactive Waste Management has evaluated six storage concepts and considers all to be acceptable and feasible (Section A.2.2). A final storage concept could be selected, designed, and licensed, and the facility built within five to 10 years of selecting the site.

If the Department adopts the multi-purpose canister strategy, multi-purpose canisters could be made available as early as January 1998 to utilities that need additional at-reactor storage. The multi-purpose canister strategy would alleviate the need for the utility to maintain the spent fuel pool after reactor shutdown, possibly resulting in considerable long-term cost savings because of reduced operations. When either the monitored retrievable storage facility or the repository begins operating the multi-purpose canisters could be transported directly from the reactor site without having to be returned to the pool for reloading into a transportation cask. The Nuclear Regulatory Commission has ruled that spent nuclear fuel can be safely stored on-site without significant environmental effect for at least 30 years beyond the licensed life of the reactor.

Finally, as noted in Figure 6-2, the interim storage of nuclear waste may not be necessary until 2030 for existing plants that renew their licenses and until approximately 2050 for new plants. If a first repository is accepting nuclear waste at that time, interim storage of spent nuclear fuel at a monitored retrievable storage facility may be more acceptable to a potential host.

6.2.3 Waste Transportation

The Department of Energy is developing a system to transport spent nuclear fuel and high-level radioactive waste. The wastes will be transported to facilities in the waste-management system in casks certified by the Nuclear Regulatory Commission (Section A.2.2). The transportation system, which is still under development, could be used to transport the waste produced by all scenarios.

The waste generated in the scenarios may require cask types different from those being developed now. As noted in Section A.2.2, however, only "from reactor" casks for transporting spent nuclear fuel are currently being developed. The other casks will be developed later. Therefore there is ample opportunity to develop casks to transport other waste types when and if the need arises.

An increase in the amount and types of waste and the location of these wastes will have an effect on the transportation system used by the Department of Energy. These impacts potentially will include the need for additional shipping cask designs, additional equipment and personnel, and training and assistance for public safety officials along routes not previously affected by civilian or defense waste shipments. The activities needed to address these impacts are ongoing in the development of the transportation system necessary to move the wastes under the OCRWM program. The methods selected to transport these wastes will be dictated in large part by the capabilities of the generator or storage sites. Since cask design, certification, and procurement will require about five years, there will be ample time to adjust the transportation system to accommodate additional wastes.

6.2.4 Waste Acceptance

The Department of Energy is required to accept waste for disposal from all the owners and generators of spent nuclear fuel and high-level radioactive waste. Civilian owners and generators of those wastes are required to execute a contract with the Department that is consistent with the Standard Contract for the Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste (10 CFR Part 961; Standard Contract). Federal agencies or departments requiring the Department's disposal services will be accommodated by an interagency agreement reflecting, as appropriate, the terms and conditions set forth in the Standard Contract (See Section A.3.1). The waste-acceptance program described in Section A.3.1 is designed to be flexible enough to accommodate the changes in spent nuclear fuel generation, high-level radioactive waste production projected in the scenarios and high-level radioactive waste that may be designated by the Nuclear Regulatory Commission.

6.2.5 Costs and Funding of the Civilian Radioactive Waste-Management Program

The Nuclear Waste Policy Act requires that all waste-management program costs be paid by the generators or owners of the spent nuclear fuel and high-level radioactive waste. Since the Department of Energy periodically estimates the cost of the program and assesses the adequacy of the current civilian fee structure to cover all civilian costs, changes brought about by the waste produced in the scenarios would be identified, and adjustments would be made as needed. A formal payment schedule for defense waste is being prepared (Section A.1.5).

6.2.6 Regulatory Framework of the Waste-Management Program

The U.S. Environmental Protection Agency sets standards that protect public health and safety and the environment from offsite releases of radioactive material in repositories. The Nuclear Regulatory Commission establishes technical requirements and criteria used to authorize the construction of a repository and to approve licenses for the acceptance and possession of waste at a repository (Section A.1.1). Environmental Protection Agency standards would apply to all nuclear waste produced in the scenarios. Likewise, the Commission's requirements, including those for the construction and operation of the waste-management system, waste transportation, and the decommissioning of a repository, would be applicable to all those nuclear wastes.

With few exceptions, the Department of Energy considers that the standards, requirements, and criteria described above do not depend on the types or the amounts of nuclear waste to be managed and emplaced in a repository. Further, the Department of Energy must demonstrate that it meets the standards, requirements, and criteria for each type of waste and for the amount to be disposed; the standards themselves would not need to be adjusted as new waste types and new amounts are accepted to the waste-management system. One exception is this: The Commission's technical criteria contain some restrictions on the design criteria for high-level radioactive waste packages (10 CFR 60.135). However, none of the high-level radioactive waste produced in the cases with new nuclear power plants conflict with those criteria.

6.2.7 Decision to Emplace Defense Waste with Commercial Waste in the Same Repository

Current programs and plans call for the disposal of both defense and commercial wastes in the same repository. This plan is based on a Department study (published in 1985) that was required by Section 8 of the Nuclear Waste Policy Act of 1982.[32] That study assumed that initially 20,000 canisters of defense-related high-level radioactive waste would be emplaced in a repository. Cost savings led the Department to recommend to the President that defense waste should be emplaced with commercial waste. On April 30, 1985, the President determined there was no basis on which to conclude that a defense-only repository is required.

In both scenarios with new reactors, 48,900 canisters of defense-related high-level radioactive waste require disposal in a repository. While no cost analysis has been made, the additional 28,900 canisters are not expected to change the Department's original recommendation to the President.

6.3 ALTERNATIVE SCENARIO ASSUMPTIONS

The scenarios described in Section 6.1 and analyzed in Section 6.2 are derived from many assumptions regarding energy demand, the number and types of nuclear power plants, how spent nuclear fuel and high-level radioactive waste will be processed prior to geologic disposal, and the types of waste that will require geologic disposal. This section identifies how changes to some of the important assumptions would affect the scenarios. Examination of these alternative scenario assumptions indicate that the values used in this analysis appear to be bounding.

6.3.1 Early Retirement of Commercial Nuclear Power Plants

Less spent nuclear fuel from light-water reactors would have been produced in the scenarios with new commercial nuclear power reactors if the early retirement of existing nuclear power plants had been assumed.

The retirement of nuclear power plants before their 40-year licenses have expired would end the discharge of spent fuel by those plants. In addition, it may create greater demand for interim storage to facilitate the decommissioning of the retiring plants.

6.3.2 License Renewal of Commercial Nuclear Power Plants

Commerical utilities can request an extension of their initial 40-year operating license of commercial nuclear power plants. The Nuclear Regulatory Commission decides on such renewals. Renewal will affect spent nuclear fuel projections, because spent nuclear fuel is generated during the additional years of plant operation. The upper-bound scenario assumes that the operating licenses of 70 percent of all operating units will be renewed for 20 years. In the reference scenario, license renewal is not assumed.

The future of license-renewal programs in the United States, dependent on utility plans and decisions, is uncertain, making spent nuclear fuel projections less certain. Plans to renew the licenses of two units, Monticello and Yankee Rowe, have been cancelled. The primary reasons for cancelling the plans were the cost of testing and refurbishment needed to obtain Nuclear Regulatory Commission approval and the regulatory uncertainties associated with the Commission's license-renewal rule and implementation guidance.[33]

6.3.3 Energy Policy Act Efficiency Standards

Many provisions of the Energy Policy Act of 1992 are designed to assist the nuclear power industry to achieve levels of energy generation assumed in the upper-bound scenarios. However, the production of all commercial power production wastes would have decreased in the scenarios if they had assumed the consequences of efficiency standards in the Energy Policy Act.

It is expected that the Act will significantly affect energy markets by reducing the demand for energy produced by the power industry. One provision of the Act requires the Secretary of Energy to set minimum efficiency standards for all new Federal buildings and for all buildings that receive federally backed mortgages. Efficiency standards are required for electric motors, lights, and commercial-industrial equipment.

6.3.4 Phase-Out of Spent Nuclear Fuel Reprocessing by the Department of Energy

Recently, the Department of Energy decided to phase out the reprocessing of spent nuclear fuel to recover highly enriched uranium to support the weapons complex. The Idaho and Savannah River sites are preparing plans to do so. Only existing high-level radioactive waste will be processed, solidified, and poured into canisters. Subsequent to the phase-out of reprocessing, high-level radioactive waste will no longer be produced during recovery of nuclear material from spent nuclear fuel.

The Integrated Data Base of 1992 forecasts the number of canisters of high level waste that would be produced by the Idaho site. The Integrated Data Base assumes that the site's projected fuel delivery, reprocessing, and waste-management would continue through 2030. The Integrated Data Base also assumes that, at the Savannah River site, one production reactor would operate from 1993 through 2007, and the spent nuclear fuel from the reactor would be reprocessed.

The phase-out decision will reduce the number of canisters to be produced at the Idaho and Savannah River sites in comparison with the number projected by the 1992 Integrated Data Base. As a result, there will be more spent nuclear fuel (See Section 7.1.3). At this stage of planning, the differences in amounts of high-level radioactive waste and spent nuclear fuel will not alter our conclusions.

6.3.5 Alternative Technologies for the Partitioning and Transmutation of Spent Nuclear Fuel

Technology for the aqueous reprocessing of existing and new light-water reactor spent nuclear fuel is well established, although it is not currently practiced in the United States because of economic reasons. However, aqueous-reprocessing technology could be an option for reprocessing spent nuclear fuel. Using the same method of analysis employed in Section 5 and data from one of the studies cited there,[9] waste volumes resulting from the aqueous reprocessing of spent nuclear fuel are estimated to be roughly equivalent to the pyroprocessing waste volumes shown in Table 5-1. Aqueous waste volumes can be predicted with greater certainty, since there is more experience with this technology. The choice of aqueous or pyrochemical reprocessing technology is not expected to significantly affect the waste volumes resulting from reprocessing spent nuclear fuel.

Transmutation of undesirable elements in spent-fuel reprocessing wastes could also be accomplished using particle accelerators. Accelerator-based devices can transmute a variety of isotopes, including long-lived fission products such as technetium-99 and iodine-129.[34,35,36] Such devices can also produce electrical power.[37] Accelerator transmutation methods would probably produce a larger total volume of waste materials than direct disposal of spent nuclear fuel.[38] Most of this waste, however, would consist of short-lived radioisotopes which may only require interim storage to allow their decay.

6.3.6 Other Sources of Repository-Bound Waste

If any (or all) other possible sources of spent nuclear fuel and high-level radioactive waste had been assumed in the scenarios, then the scenarios would have produced higher volumes of those other wastes. To complete our analysis, it was necessary to establish a limited number of sources of spent nuclear fuel and high-level radioactive waste. The intent is not to ignore other sources and types of radioactive materials that also require geologic disposal in the radioactive waste-management system.

Current programs and plans focus on developing a system for managing spent nuclear fuel from commercial nuclear power plants and high-level radioactive waste solidified at four sites. However, other wastes in a variety of forms may also be emplaced in a repository. Further analysis of these materials is provided in Section 7.

7. MISCELLANEOUS WASTES NOT INCLUDED IN THE SCENARIOS

The preceding scenarios did not take into account all sources of nuclear wastes that might eventually be emplaced in a geologic repository. This section describes some other potential waste sources. The miscellaneous wastes described in this section are not included in the preceding scenarios because treatment and disposal options for these wastes are not as well defined as for waste types included in the scenarios. This is not considered a major shortcoming to the analysis because the amount of miscellaneous wastes is small relative to the wastes included in the scenarios, and the general characteristics of the miscellaneous wastes are not significantly different from the characteristics of the waste included in the scenarios. ~~The volume of additional wastes discussed in this section is small compared with the spent nuclear fuel and high-level radioactive waste detailed in the scenarios. Treatment and disposal options for these wastes have not been established. For some of these wastes, characteristics and amounts are not well defined.~~

~~The information in this section has been derived primarily from the Integrated Data Base for 1992[3] and the Department of Energy's Office of Environmental Restoration and Waste Management.~~

For some of these miscellaneous wastes, specific characteristics and amounts are not currently well defined and future amounts are not well known. Accordingly, only estimates can be made of the amount of some of these materials, and projections are based on these estimates. Programs have been initiated by the Department of Energy to better define these materials and to establish more rigorous waste management procedures for tracking, storage, conditioning, and ultimate disposal. The information in this section has been derived primarily from the Integrated Data Base for 1992[3], Greater-Than-Class C Low-Level Radioactive Waste Characterization: Estimated Volumes, Radionuclide Activities, and Other Characteristics[32] and the Department of Energy's Office of Environmental Restoration and Waste Management.

7.1 MISCELLANEOUS SPENT NUCLEAR FUEL

~~This section concerns spent nuclear fuel produced by sources other than those covered in the scenarios in Section 6. The Nuclear Waste Policy Act of 1982 requires that this spent nuclear fuel also be emplaced in a geologic repository.~~

The previous cases and scenarios described in this report include spent nuclear fuel from civilian nuclear power reactors. Not considered in the scenarios are spent nuclear fuel from research reactors, naval reactors, and Department of Energy weapons-material-production reactors. Should the Department decide to dispose of this material the Nuclear Waste Policy Act of 1982 requires emplacement in a geologic repository. In addition, since spent nuclear fuel reprocessing was discontinued by the Department of Energy in 1992, there are spent fuel materials formerly scheduled for reprocessing that will likely be directed to a geologic repository. There also exists spent nuclear fuel of U.S. origin at foreign reactors and these fuels may be disposed of in a U.S. repository. While the quantity of these materials is not accurately known, an estimate can be made of the potential amount in each category and the potential total amount that may eventually be scheduled for disposal in a geologic repository. Table 7-1 summarizes the current best estimate of the amount of miscellaneous spent nuclear fuel and a projection of the amount to the year 2030.

7.1.1—~~National~~ Integrated Spent Nuclear Fuel ~~Management~~ Program

~~The facilities needed to prepare the miscellaneous spent nuclear fuel described in this section for disposal in a geologic repository do not exist. During 1992, the Idaho National Engineering Laboratory staff began to study how to treat spent nuclear fuel before it is emplaced in a repository.~~

~~Most of the Department of Energy's spent nuclear fuel is highly enriched uranium. The safety of its storage is a concern because some of the non-naval spent nuclear fuel has degraded and certain facilities for storing it have become obsolete. The Department of Energy will establish a national policy for its spent nuclear fuel. The new National Spent Fuel Management Program will work with the Civilian Radioactive Waste Management Program.~~

The Department of Energy is currently developing an integrated, long-term program to provide for the storage, conditioning, and final disposition of all spent nuclear fuel in the current or future possession of the Department of Energy. Spent nuclear fuel is currently located at a number of Department of Energy sites with the majority located at the Idaho National Engineering Laboratory, the Hanford Site and the Savannah River Site. The Integrated Spent Nuclear Fuel Program will define appropriate waste conditioning methods for this material and work with the Civilian Radioactive Waste Management Program to define compatible waste acceptance criteria for geologic disposal.

7.1.2—~~Experimental and Special Spent Nuclear Fuel and Debris~~ Research Reactor and Special Spent Nuclear Fuel and Debris

~~The Department of Energy is storing about 260 metric tons of spent nuclear fuel from its research reactors and certain commercial reactors. This is less than 0.3 percent of the total amount of high-level radioactive waste and spent nuclear fuel to be emplaced in a repository in the reference scenario (Section 6.1.1).~~

~~The Department will determine what special treatment methods are needed and establish criteria for emplacing of this spent nuclear fuel in a geologic repository.~~

Table 7-1

Miscellaneous Spent Nuclear Fuel
That May Require Geologic Disposal

Source	1992 Estimate (metric tons)	2030 Projection (metric tons)
Department of Energy Research Reactors	12	24[1]
University Research Reactors	~0	4
Civilian Development Programs	100	100[2]
Nuclear Fuel Debris (TMI Unit 2)	83	83
West Valley Demonstration Project	26	26
Fort St. Vrain	12	28
Foreign Research Reactors	3	12
Department of Energy Production Reactors	2,284	2,284[2]
U.S. Naval Reactors	6	20
TOTAL	2,526	2,581

Notes:

1. The 1992 estimate is for 40 years of research; at the same rate, the cumulative inventory will double in another 40 years.
2. These programs are largely inactive and are assumed to remain so through 2030.

Spent Nuclear Fuel Generated by U.S. Research Reactors And Stored at Department of Energy Sites

The Department of Energy has operated research reactors, resulting in the storage of spent nuclear fuel at several sites. The Idaho National Engineering Laboratory, the Hanford site and the Savannah River site store most of the spent nuclear fuel on site. The remainder is stored at the Oak Ridge site, the Los Alamos National Laboratory, the Brookhaven National Laboratory and the West Valley site. The radioactive materials produced by the reactors are intact experimental spent nuclear fuel elements and solids that will not be reprocessed.

Research reactors have used several forms of fuel: molten salt, aluminum clad, carbide, and metallic fuels. However, two types dominate: a standard type that closely resembles light water reactor fuel and a nonstandard type. The standard type of fuel resembles commercial reactor fuel and can be similarly handled and stored. Nonstandard fuel requires special handling and storage.

Spent Nuclear Fuel From U.S. Research Reactors That Is Not Stored at Department of Energy Sites

Universities in the United States and its territories have operated 71 reactors for research. About 40 of the reactors are now operating. Many types and forms of nuclear fuel have been used. Half of this spent nuclear fuel is stored by the Department of Energy, and the remainder is stored at the reactors.

Commercial Reactor Spent Fuel at Department of Energy Sites

The Department of Energy stores intact, consolidated spent nuclear fuel produced in research to support the development of commercial nuclear power in the United States. The Department also stores core debris from the Three Mile Island nuclear power plant.

The largest quantities of spent nuclear fuel in this category are stored at the Idaho National Engineering Laboratory. Thirty-four metric tons of spent nuclear fuel at that site came from the Fermi-1 research reactor. An additional 38 metric tons of intact and consolidated pressurized-water reactor fuel at the site were produced during tests of storage casks. The Idaho National Engineering Laboratory also stores 74 metric tons of core debris from the Three Mile Island nuclear power plant. Another 27 metric tons of spent nuclear fuel from pressurized water and boiling water reactors are stored at the West Valley site. The Department of Energy plans to use that spent nuclear fuel to demonstrate the performance of transportable storage casks.

Spent Nuclear Fuel From Foreign Research Reactors

The Department of Energy has proposed the Foreign Research Reactor Spent Nuclear Fuel Acceptance Policy. This policy would support nonproliferation of weapons-usable material by eliminating the use of highly enriched uranium in research reactors. The Acceptance Policy is

~~consistent with Section 903(a) of the Energy Policy Act of 1992, which restricts the export of highly enriched uranium from the United States.~~

~~An important part of the proposed Acceptance Policy is the Reduced Enrichment Research and Test Reactor Program. The program would provide incentives and opportunities to all foreign countries to return U.S. origin spent nuclear fuel containing highly enriched uranium. Approximately 6,000 spent nuclear fuel assemblies are overseas. In 10 years, the number could double. The Department of Energy anticipates that most of the assemblies will be returned, and the Department of Energy would store it and eventually emplace it in a geologic repository.~~
~~Spent Nuclear Fuel Generated by U.S. Research Reactors And Stored at Department of Energy Sites~~

The Department of Energy has operated a variety of research reactors over the past four decades. These research activities have resulted in the generation of spent nuclear fuel with approximately 12 metric tons currently stored at several locations. Most of the spent nuclear fuel from research reactors is stored at the Idaho National Engineering Laboratory, the Hanford Site and the Savannah River Site. Relatively minor amounts of spent fuel are also stored at Oak Ridge National Laboratory, Los Alamos National Laboratory, and Brookhaven National Laboratory. These materials are largely intact spent nuclear fuel elements of various experimental designs. For the purposes of this analysis, it is conservatively estimated the amount of this spent nuclear fuel will double by the year 2030, which represents approximately 40 additional years of reactor research and eventual decommissioning of existing research reactors.

Universities in the United States and its territories have operated 71 nuclear reactors for research. Approximately 36 of these reactors are currently operating; the others have been shut down. Many types and forms of nuclear fuel have been used in these research reactors. Approximately one half of the spent nuclear fuel is currently stored at Department of Energy sites. The remainder is stored at the reactors. Information on the quantity of spent fuel currently stored at these reactors indicates that approximately 4.4 metric tons will be added to the Department inventory over the next 10 years. The Integrated Spent Nuclear Fuel Program will quantify this material and assure its proper handling and disposal.

The Department of Energy has possession of about 100 metric tons of spent nuclear fuel which was produced as a result of research supporting the development of commercial nuclear power. Most of the spent nuclear fuel in this category is stored at the Idaho National Engineering Laboratory and the Savannah River Site. In addition, 83 metric tons of core debris from the Three Mile Island plant is currently located at the Idaho National Engineering Laboratory. Another 26 metric tons of spent nuclear fuel from pressurized-water and boiling-water reactors is stored at the West Valley Demonstration Project site. Twelve metric tons of spent fuel from the Fort St. Vrain plant is at the Idaho National Engineering Laboratory. These quantities are unlikely to change significantly between now and 2030 because Department of Energy programmatic development of commercial nuclear power has largely been discontinued.

The Department of Energy has proposed an acceptance policy for spent nuclear fuel of U.S. origin from foreign research reactors. This policy would support nonproliferation of weapons-usable material by eliminating the use of highly enriched uranium in research reactors. The acceptance policy is consistent with Section 903(a) of the Energy Policy Act of 1992, which restricts the export of highly enriched uranium from the United States. An important part of the proposed acceptance policy is the Reduced Enrichment Research and Test Reactor Program. The program provides incentives and opportunities to all foreign countries to return U.S.-origin spent nuclear fuel containing highly enriched uranium.

Approximately 6,000 spent nuclear fuel assemblies currently exist overseas. In 10 years, the number could double. It is anticipated that most of the assemblies will be returned, and the Department of Energy will store the material and eventually emplace it in a geologic repository. Detailed information is not currently available. However, if it is assumed that these spent fuel assemblies are on the average about equivalent in size to the average U.S. university research reactor assembly (a very conservative estimate), the total amount of this spent nuclear fuel currently in storage may be estimated to be approximately 3.1 metric tons. The projection for 2030, assuming no expansion of these programs, is 11.6 metric tons, representing approximately 12,000 fuel assemblies.

7.1.3 Spent Nuclear Fuel from Department of Energy Production Reactors and From U.S. Naval Reactors

~~The Department of Energy stores spent nuclear fuel from its production reactors and from U.S. naval reactors. According to the 1992 Integrated Data Base, 2,128 metric tons of spent nuclear fuel are stored at the Hanford site.~~

~~The Idaho National Engineering Laboratory stores 874 metric tons of spent nuclear fuel from the commercial reactors discussed in Section 7.1.2 and from U.S. naval reactors.~~

~~During April 1992, the Secretary of Energy decided to phase out the reprocessing of spent nuclear fuel that recovered highly enriched uranium. The Idaho National Engineering Laboratory and the Savannah River site are preparing to phase out their reprocessing. The Department has also ended reprocessing at the Hanford site, where 2,128 metric tons of N-Reactor production fuel are stored. This spent nuclear fuel will be stored and prepared for disposal in a geologic repository.~~

The Department of Energy is discontinuing the reprocessing of spent nuclear fuel to recover highly enriched uranium. Facilities at the Hanford Site, the Idaho National Engineering Laboratory and the Savannah River Site are phasing out reprocessing operations. Spent fuel previously scheduled for reprocessing will be stored on-site and eventually prepared for geologic disposal. Approximately 2,100 metric tons of Department of Energy production reactor spent nuclear fuel is stored at the Hanford site. With the phase-out of reprocessing of production reactor fuel and target fuel at the Savannah River site, another 184 metric tons of spent nuclear fuel will require disposal.

Another 5.5 metric tons of spent nuclear fuel from U.S. naval reactors is stored at the Idaho National Engineering Laboratory awaiting reprocessing. It is projected the amount of naval reactor spent fuel could increase to 19.7 metric tons by 2030 as a result of continuing defense programs.

7.2 GREATER-THAN-CLASS-C LOW-LEVEL RADIOACTIVE WASTE

~~Greater-than-Class-C low-level radioactive waste generated by the licensees of the Nuclear Regulatory Commission must be emplaced in a geologic repository, unless the Commission approves another means of disposal (10 CFR 61.55(a)(2)(iv)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 assigned to the Department of Energy the responsibility for such waste.~~

~~Low-level radioactive waste that is suitable for near-surface disposal is classified as A, B, or C depending on the concentrations of various radionuclides in the waste. Low-level radioactive waste that exceeds the radioactivity limits of Class C (10 CFR Part 61.55) has been produced by licensees of the Nuclear Regulatory Commission or Agreement States.~~

~~Some greater-than-Class-C low-level radioactive wastes are reactor decommissioning wastes, non-fuel-bearing components, sealed sources of radiation, and spent nuclear fuel disassembly hardware including structural components left after the irradiated fuel pins are removed from fuel assemblies during consolidation. That hardware consists of end fittings, grid spacers, water rods from recently designed boiling-water reactors, control rod guide tubes from pressurized-water reactors, and various nuts, washers, and springs. Some non-fuel-bearing components are fuel channels from boiling-water reactors, control rods, fission chambers, neutron sources, and thimble plugs.~~

~~Other materials also exceed the radioactivity limits of 10 CFR Part 61.55. They include sealed sources of carbon-14, cobalt-60, strontium-90, cesium-137, plutonium-238, plutonium-239, and americium-24. These materials are found in various tools and machines used in industry and medicine. They are also used in geological research.~~

~~The Department's Office of Environmental Restoration and Waste Management describes in its Five-Year Plan a three-phase plan to store and dispose of greater-than-Class-C low-level radioactive waste.[39] The first phase, now in progress, will provide for the interim storage of a limited amount of the waste. During fiscal year 1992, the Department began to prepare the environmental documentation needed to select a facility for the interim storage of sealed sources. During the second phase, the Department will develop a central facility to store commercial greater-than-Class-C low-level radioactive waste; the temporary facility will be used until a facility licensed by the Commission becomes available. During the third phase, the Department will provide for the disposal of greater-than-Class-C low-level radioactive waste either in a facility that will contain only that waste or in a geologic repository that will also contain high-level radioactive waste. (The Nuclear Waste Policy Act, does not require the latter choice.) The Five-Year Plan states that the greater-than-Class-C low-level radioactive waste will probably~~

not be disposed of for many years. The Department of Energy is studying the appropriate methods for treating and disposing of such waste.

Under the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240, Title 1, Section 3), the Department of Energy is responsible for disposal of low-level radioactive waste generated by Nuclear Regulatory Commission licensees that exceeds class C limits given in 10 CFR 61.55(a). The regulation requires disposal of "Greater-Than-Class C low-level radioactive waste" in a deep geologic repository unless other means of disposal are approved by the Nuclear Regulatory Commission. Other disposal concepts are being studied.[26,33] A large proportion of the volume of this waste consists of non-fuel hardware components, including control rod blades, fuel channels from boiling-water reactors, fission chambers, neutron sources and thimble plugs. At least 85 percent of this material results from commercial nuclear utility operations[32]. A relatively small volume of greater-than-class C low-level waste consists of obsolete sealed radiation sources of no recyclable value.

The Department of Energy's current reference case projection[32] is that 3,243 cubic meters (115,000 cubic feet) of packaged greater-than-class C low-level waste will be produced by 2035. Among options for disposal of greater-then-class C low-level waste in a geologic repository is disposal in canisters in a manner similar to high-level waste. Assuming this is the case, the projected volume of waste is approximately equivalent to the storage volume of 3,662 canisters 2 feet by 10 feet each. There may be more appropriate ways to emplace these generally low-heat wastes in a repository while occupying significantly less space.

7.3 OTHER RADIOACTIVE WASTES NOT ASSUMED IN SCENARIOS

The Nuclear Waste Policy Act does not require the emplacement of the following materials in a geologic repository managed by the Office of Civilian Radioactive Waste Management: Waste Isolation Pilot Plant non-certifiable defense transuranic waste, low-level radioactive waste that exceeds site-specific performance assessment limits, and radionuclides (mainly plutonium isotopes) resulting from the decommissioning of nuclear weapons. The 1992 Integrated Data Base[3] does not contain information on these wastes. The Department will obtain more information on the amounts and characteristics of these materials as we continue to update information for the Integrated Data Base.

Other sources of radioactive material that may require geologic disposal could come from dismantling and decommissioning the tanks and facilities at which high-level radioactive waste is currently stored. In addition, the long-term disposition of plutonium and highly enriched uranium from dismantling excess nuclear weapons has not been determined.

The Nuclear Waste Policy Act does not address the disposal of certain categories of radioactive wastes that may eventually be considered for a geologic repository. Included among these wastes are:

- Waste Isolation Pilot Plant non-certifiable defense transuranic waste.

- Low-level radioactive waste that exceeds site-specific performance assessment limits.
- Radioactive material from the dismantling and decommissioning of storage tanks and other facilities at which high-level radioactive waste is currently stored.
- Excess plutonium and highly enriched uranium resulting from the decommissioning of nuclear weapons.

The Integrated Data Base for 1992 contains no information on these materials. The Department of Energy plans to continue its assessment of the types and volumes of wastes that might be expected from these sources and will update the Integrated Data Base to document its assessment.

As a result of dismantling U.S. nuclear weapons, there will be an inventory of excess highly-enriched uranium and weapons-grade plutonium. The amount of this material is expected to be approximately 50 to 100 metric tons of plutonium, and 400 metric tons of highly enriched uranium. Additionally, a similar amount of ex-Soviet highly enriched uranium and plutonium may be purchased from Russia as part of a safeguards agreement.

Among the disposition options being considered by the Department at this time are: long-term storage for eventual utilization in submarine, warship, or power reactors; transmutation; or disposal. At the present time, it is not considered economical to modify existing reactors or to build new ones to utilize the highly enriched uranium as fuel. Since safeguards and safety issues currently override the use of highly enriched uranium as an energy asset, disposal is the most likely option. Methods of disposal being studied include dilution with low enriched uranium or mixing with the borosilicate glass which will be produced at the Defense Waste Processing Facility at the Savannah River Site. However, long-term storage of highly enriched uranium and plutonium will continue until the Department determines its policy for final disposition.

7.4 CUMULATIVE IMPACT OF MISCELLANEOUS WASTES NOT INCLUDED IN THE SCENARIOS

The miscellaneous wastes discussed in this chapter may be destined for disposal in a geologic repository when a suitable facility becomes available. In some cases, the total amount and the characteristics of the waste are not yet well known. The Department of Energy has initiated programs to better characterize the materials and determine conditioning and packaging methods for long-term storage and eventual geologic disposal. Given the uncertainty concerning the current amount and characteristics of this material and of activities generating the material, the 2030 projections must be recognized as even less certain. Notwithstanding these uncertainties, an initial estimate may be made of the current and future amount of these waste materials. This estimate is summarized in Table 7-2. The 2030 projection of 2,581 metric tons of spent nuclear fuel and 3,662 canisters of greater-then-class C low-level waste represents potential increased waste volumes of between two and 15 percent depending on the scenario and the type of waste considered.

Table 7-2

Cummulative Impact Of Miscellaneous Wastes Not Included In The Scenarios

	Original Scenario	Additional Miscellaneous Wastes	Percent Increase
Reference Scenario			
Spent Nuclear Fuel	85,700 metric tons	2,581 metric tons	3.0%
High-Level Waste	23,900 canisters	3,662 canisters[1]	15.3%
Upper-Bound Scenario			
Spent Nuclear Fuel	115,800 metric tons	2,581 metric tons	2.2%
High-Level Waste	48,900 canisters	3,662 canisters[1]	7.5%
Advanced Liquid-Metal Reactor Scenario			
Spent Nuclear Fuel	74,900 metric tons	2,581 metric tons	3.4 %
High-Level Waste	95,000 packages and canisters	3,662 canisters[1]	3.9%

1. These are canisters of Greater-Than-Class C low-level radioactive waste.

8. CONCLUSIONS

On the basis of the scenario analysis in Section 6.2 and on the consideration of other sources of repository-bound waste (Section 7), the Department concludes that current programs and plans for management of nuclear waste, as mandated by the Nuclear Waste Policy Act of 1982, are adequate for any additional volumes or categories of nuclear waste generated by new nuclear power plants that might be constructed and licensed after October 24, 1992. We also conclude that current programs and plans are adequate for managing potential additional volumes and categories of high-level radioactive waste resulting from the Department's waste stabilization and disposal programs. These conclusions result from the following findings:

1. ***Radioactive materials from new nuclear power plants and most other radioactive materials not managed as part of the current waste-management system will not be generated until well into the future.*** ~~Current programs and plans related to the need for a second repository (Section 6.2.1), interim storage (Section 6.2.2), and transportation (Section 6.2.3) are adequate because there is sufficient time to develop systems and facilities to manage additional waste that might be generated under the future waste generation scenarios.~~

2. ***Flexibility has been built into the current programs and plans.*** ~~The waste acceptance program is designed to be flexible enough to accommodate changes in waste generation projected in the scenarios (Section 6.2.4). Since both program costs and the fee structure are assessed periodically, changes to either can be identified, and adjustments can be made when appropriate (Section 6.2.5). With few exceptions, the standards, requirements, and criteria within the current regulatory framework of the program do not depend on the types and amounts of nuclear waste to be managed and emplaced in a repository (Section 6.2.6).~~

3. ~~***The development of the waste-management system is at an early stage, allowing ample opportunity to adjust to changes in needs.***~~ *The development of the waste management system for current waste types will not be significantly affected by the additional waste types envisioned in this evaluation.* ~~Current programs and plans focus on developing a system to manage spent nuclear fuel from commercial nuclear power plants and solidified high level radioactive waste from Department activities. However, the radioactive materials described in Section 7 may also require geologic disposal. The program will be able to adapt to changing requirements and provide for orderly change in the waste management system.~~

4. ***The Department's total inventory of radioactive materials requiring repository disposal will not increase significantly from current amounts.*** ~~The Department's spent nuclear fuel inventory represents less that five percent of the maximum amount of spent nuclear fuel anticipated from commercial plants. With the phase-out of reprocessing to recover highly enriched uranium, very little additional high level radioactive waste will be~~

generated. ~~Current programs and plans are adequate to manage all of the Department's spent nuclear fuel and solidified high-level radioactive waste.~~

The Department readily admits that it faces formidable challenges in implementing its programs and plans for managing waste from existing nuclear power plants. Changing circumstances within and outside the Department will add to those challenges and prompt changes in plans and programs. However, the Department does not view this report as the vehicle for addressing those concerns.

This report focuses on provisions of the Nuclear Waste Policy Act, rather than how the Department is currently implementing them. It also focuses primarily on waste that may be generated by new nuclear power plants rather than existing nuclear power plants. With these distinctions in mind, the four findings that led to the conclusions are explained in more detail.

Radioactive materials from new nuclear power plants and most other radioactive materials not managed as part of the current waste-management system will not be generated until well into the future.

Current programs and plans are adequate because there is sufficient time to develop systems and facilities to manage additional waste that might be generated by new nuclear power plants. The first new nuclear power plants may begin operation in 2010. It is assumed they would operate for 40 years and spent nuclear fuel can be safely stored for at least 30 years beyond that. Under current programs and plans the Department is required to determine the need for a second repository between 2007 and 2010. As explained in Section 6.2.1, the timing of this determination is adequate to manage waste from potential new nuclear power plants. Other considerations are interim storage (Section 6.2.2) and transportation (Section 6.2.3). As explained in those sections, current programs and plans are adequate as well.

Flexibility has been built into the current programs and plan.

Current programs and plans provide the flexibility to adjust to additional volumes or categories of nuclear waste that may be generated by new nuclear power plants. For example, the waste-acceptance program is designed to be flexible enough to accommodate changes in waste generation projections (Section 6.2.4). This is not to say that current cost estimates will be sufficient to cover costs for emplacing waste from future nuclear power plants. They will not. However, since program costs and the fee structure are assessed periodically, changes to either will be identified, and adjustments will be made when appropriate (Section 6.2.5).

The development of the waste-management system for current waste types will not be significantly affected by the additional waste types envisioned in this evaluation.

Current programs and plans focus on developing a system to manage spent nuclear fuel from commercial nuclear power plants and solidified high-level waste from Department activities.

The additional radioactive materials described in the scenarios and in Section 7 are similar enough so that the program will be able to adapt to changing requirements and provide for orderly change in the waste-management system.

The Department's total inventory of radioactive materials requiring repository disposal will not increase significantly from current amounts.

The Department's spent nuclear fuel inventory represents less than five percent of the maximum amount of spent nuclear fuel anticipated from commercial plants. With the phase-out of reprocessing to recover highly enriched uranium, very little additional high-level radioactive waste will be generated. Current programs and plans are adequate to manage all of the Department's spent nuclear fuel and solidified high-level radioactive waste.

9. REFERENCES

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10. GLOSSARY OF TERMS

Accessible environment: The atmosphere, land surface, surface water, oceans, and portions of the earth's crust that are accessible to humans.

Actinides: Elements with atomic numbers from 90 to 103 inclusive.

Actinide recovery rate: The fraction of transuranic actinide elements (chiefly curium, americium, neptunium, and plutonium) are extracted for reuse or disposal during the reprocessing of spent nuclear fuel. Actinide recovery rates vary for different reprocessing technologies and are usually expressed as a percentage; e.g., a 99.99 percent actinide recovery rate means that, due to limitations of the chemical processes used, 0.01 percent of the transuranic actinides originally present in the spent fuel will remain in the process wastes.

Activation product: A radioactive material produced by bombardment with neutrons, protons, or other nuclear particles.

Advanced liquid-metal reactor (ALMR): A type of nuclear reactor designed to produce electrical power which uses a liquid metal (sodium) coolant rather than water. The reference ALMR design developed in the U.S. operates with a fast neutron spectrum and uses a metallic fuel which is particularly well suited for recycle via pyroprocessing.

Agreement state: A state that has entered into an agreement with the Nuclear Regulatory Commission (as specified by the 1954 Atomic Energy Act) and has authority to regulate the disposal of low-level radioactive waste under such an agreement. This term is used in the Low-Level Radioactive Waste Policy Act (Public Law 99-240).

Alpha decay: Radioactive decay in which an alpha particle (^4He nucleus) is emitted.

Baseline: Defined and controlled element (e.g., configuration, schedule, data, values, criteria, or budget) against which changes are measured and compared.

Beta decay: Radioactive decay in which a negative electron (beta particle) is emitted.

Boiling-water reactor: A light-water reactor in which water, used as both coolant and moderator, is allowed to boil in the core. The resulting steam is used directly to drive a turbine.

Borosilicate glass: A silicate glass containing boric oxide used to immobilize (or encapsulate) and stabilize commercial or defense high-level radioactive waste produced by reprocessing. Has low thermal expansion and enhances the solubility of many metal ions.

Burnup: A measure of reactor fuel consumption expressed as the percentage of fuel atoms that have undergone fission, or the amount of energy produced per unit weight of fuel. Burnup history refers to the length of time spent fuel remains in the reactor. There is a direct correlation between burnup history and thermal output.

By-product material: (1) Any radioactive material (except special nuclear material) yields in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material; (2) the tailings or waste products produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

Calcine: A dry granular solid formed by heating liquid high-level radioactive waste to a high temperature, thereby driving off water and decomposing nitrate and hydroxide compounds.

Canister: The structure surrounding a waste form (e.g., high-level radioactive waste immobilized in borosilicate glass and spent nuclear fuel) that facilitates handling, storage, transportation, and disposal. Before emplacement in a repository, the canister may be placed in another container.

Capacity factor: The ratio of the electrical energy actually supplied by a power plant in a given time interval to the electrical energy that could have been produced at continuous full-power operation during the same time period.

Capsules: Stainless steel cylinders containing strontium or cesium isotopes reclaimed from high-level radioactive wastes produced by defense reactor spent fuel reprocessing at the Hanford site.

Cask: A container used to transport and/or store irradiated nuclear fuel or high-level nuclear waste. It provides physical and radiological protection and dissipates heat from the fuel.

Characterization: The collecting of information necessary to evaluate suitability of a region or site for geologic disposal of spent nuclear fuel and high-level radioactive waste. Data from characterization will be used during the licensing process for the geologic repository.

Cladding: A corrosion-resistant tube, commonly made of zirconium alloy or stainless steel, surrounding the reactor fuel pellets, which provides protection from a chemically reactive environment and containment of fission products.

Code of Federal Regulations (CFR): A documentation of the general rules by the executive departments of the Federal government. The code is divided into 50 titles that represent broad areas subject to federal regulation. Each title is divided into chapters that usually bear the name of the issuing agency. Each chapter is further subdivided into parts covering specific regulatory areas.

Container: A receptacle used to hold radioactive materials (usually spent nuclear fuel).

Control rod: A movable part of a reactor used to regulate the degree of fuel fissioning in the core.

Core: That part of the nuclear reactor which contains the nuclear fuel and in which most or all of the fission occurs.

Decay: The transition of a nucleus from one energy state to a lower one, usually involving the emission of a photon, electron, or neutron.

Decommissioning: Preparations taken for retirement of a nuclear facility from active service, accompanied by the execution of a program to reduce or stabilize radioactive contamination.

Decommissioning wastes: Wastes (generally low-level) collected or resulting from facility decommissioning activities.

Disposal: The isolation of radioactive materials from the accessible environment with no foreseeable intent of recovering them. Isolation occurs through a combination of constructed and natural barriers, rather than by human control. The Nuclear Waste Policy Act of 1982 specifies emplacement in mined geologic repositories.

Engineered barrier system: The constructed, or engineered, components of a disposal system designed to prevent the release of radionuclides from the underground facility or into the geohydrologic setting. It includes the thermal-loading strategy, repository design, waste form, waste containers, and backfill materials.

Enrichment, fuel: A nuclear fuel cycle process in which the concentration of fissionable uranium (i.e., ^{235}U) is increased above its natural level of 0.71 percent. (The method currently utilized in the United States is gaseous diffusion.)

Environmental Impact Statement: A report that documents the information required to evaluate the environmental impact of a project. Such a report informs decision-makers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the environment.

Exploratory facility: An underground opening and structure constructed for the purpose of site characterization at the potential site of a geologic repository.

Fault: A plane in the earth along which differential slippage of the adjacent rocks has occurred.

Fission: The division of a heavy atomic nucleus into two (or, rarely, more) parts with similar masses, usually accompanied by the emission of neutrons and gamma radiation.

Fission product: A nuclide produced by the fission of a heavier element.

Fuel assembly: A grouping of nuclear fuel rods that remain together during the charging and discharging of a reactor core.

Fuel cycle: The complete series of steps involved in supplying fuel for nuclear reactors. It includes mining, refining, enrichment, fabrication of fuel elements, use in a reactor, chemical processing to recover the fissionable material remaining in the spent fuel, reenrichment of the fuel material, refabrication of new fuel elements, and management of radioactive waste.

Fuel rod: A rod or tube made out of zircaloy into which fuel material, usually in the form of uranium pellets, is placed for use in a reactor. Many rods or tubes, mechanically linked, form a fuel assembly or fuel bundle.

Generation (electricity): The process of producing electric energy from other forms of energy; also, the amount of electric energy produced, commonly expressed in watthours (Wh).

Generation (gross): The total amount of electric energy produced by the generating units in a generating station or stations, measured at the generator terminals.

Generation (net): Gross generation less the electric energy consumed at the generating station for station use.

Geologic repository: A system, requiring licensing by the Nuclear Regulatory Commission, that is intended to be used, or may be used, for the disposal of radioactive waste in an excavated geologic medium. A geologic repository includes (1) the geologic repository operations area and (2) the portion of the geologic setting that provides isolation of the radioactive waste and is located within the controlled area.

Greater-than-Class-C low-level radioactive waste: Waste from commercial sources with radionuclide concentrations that exceed Nuclear Regulatory Commission limits for Class C low-level radioactive waste as defined in 10 CFR Part 61.55.

Ground water: Water that exists or flows in a zone of saturation between land surfaces.

Ground-water table: The upper surface of the zone of water saturation in rocks, below which all connected interstices and voids are filled with water.

Half-life: The time required for a radioactive substance to lose 50 percent of its activity by decay. Some radioactive materials decay rapidly. For example, the fission products strontium-90 and cesium-137 have half-lives of about 30 years. Others decay much more slowly: plutonium-239 has a half-life of about 25,000 years.

Hazardous waste: Nonradioactive waste containing concentrations of either toxic, corrosive, flammable, or reactive chemicals above the maximum permissible levels defined by the Environmental Protection Agency in 40 CFR Part 261 or polychlorinated biphenyl (PCBs) above maximum permissible levels as defined by the Agency in 40 CFR Parts 702-799.

High-level radioactive waste: The highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that the Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.

Interim storage: Temporary storage of spent fuel or high-level radioactive waste with the intention and expectation that the waste will be removed for subsequent treatment, transportation, and/or isolation.

Isotope: A class of atomic species, of a given element, with different atomic weights but identical atomic numbers and slightly differing chemical and physical properties.

Light-water reactor: A nuclear reactor that uses water as the primary coolant and moderator, with slightly enriched uranium as fuel.

Low-level (radioactive) waste: As specified in the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240), this is radioactive waste not classified as high-level radioactive waste, spent nuclear fuel, or by-product material specified as uranium or thorium tailings and waste.

Metric ton of heavy metal: 1,000 kilograms or about 2,205 pounds of heavy metal.

Mill tailings: Earthen residues that remain after the extraction of uranium from ores. Tailings may also contain other minerals or metals not extracted in the process.

Mixed low-level radioactive waste: Waste that satisfies the definition of low-level radioactive waste in the Low-Level Radioactive Waste Policy Amendments Act of 1985 and contains hazardous waste that has at least one of the following characteristics: (1) is listed as a hazardous waste in Subpart D of 40 CFR Part 261, (2) exhibits any of the hazardous waste characteristics identified in Subpart C of 40 CFR Part 261, or (3) waste that contains polychlorinated biphenyls which are subject to regulation under the Toxic Substances Control Act and 40 CFR Parts 702-299.

Moderator: A material used to reduce neutron energy (for fissioning if in a reactor) by elastic scattering.

Monitored retrievable storage facility: A proposed facility for the monitored retrievable storage of spent fuel from commercial power plants. Such a facility would permit continuous monitoring, management, and maintenance of these wastes and provide for their ready retrieval for further processing or disposal.

Naval propulsion reactor: A reactor used to power a naval vessel.

Neutron activation: The process of irradiating a material with neutrons so that the material is transformed to a radioactive nuclide.

Nonfuel components: Nuclear reactor core parts and hardware, excluding the nuclear fuel itself. Such components include control spiders, burnable poison rod assemblies, control rod elements, thimble plugs, fission chambers, and primary and secondary neutron sources, that are contained within the fuel assembly, or boiling-water reactor channels that are an integral part of the fuel assembly, which do not require special handling.

Nuclear reactor core: That part of the reactor which contains the nuclear fuel and in which most or all of the fission occurs.

Partitioning (partition): The extraction and separation of radioisotopes from spent nuclear fuel or from other waste. Extracted isotopes are reused, treated or disposed.

Performance assessment: Any analysis that predicts the behavior of a system or a component of a system under a given set of constant or transient conditions. In this case, the system includes the repository and the geologic, hydrogeologic, and biologic environment.

Plant capacity factor: The ratio of the electrical energy actually supplied by a power plant in a given time interval to the electrical energy that could have been produced at continuous full-power operation during the same time period.

Postclosure: The period of time after the closure of the repository.

Preclosure: The time period before the backfilling of the repository.

Pressurized water reactor: A reactor system that uses pressurized water in the primary cooling system. Steam formed in a secondary cooling system is used to turn turbines to generate electricity.

Production reactor: A reactor whose primary purpose is to produce fissile or other materials or to perform irradiation on an industrial scale. Unless otherwise specified, the term usually refers to either a tritium- or plutonium-production facility used to produce materials for nuclear weapons.

PUREX process: A solvent extraction process that may be employed in the reprocessing of uranium and plutonium-based nuclear fuels.

Pyroprocessing: A technology for reprocessing spent nuclear fuel which uses high temperatures and molten salt and molten metal solvents to electrolytically separate the fission product, uranium, and transuranic fractions of the spent fuel.

Radioactivity: The spontaneous emission of radiation from the nucleus of an atom producing daughter nuclides). Radioisotopes of elements lose particles and energy through this radioactive decay. Radioactivity is measured in terms of the number of nuclear disintegrations occurring in a unit of time. A unit of activity commonly used is the curie, which is 3.7×10^{10} disintegrations per second.

Radionuclide: A radioisotope that decays at a characteristic rate by the emission of particles or ionizing radiation.

Radionuclide migration: The movement of radionuclides, generally in liquid or gaseous forms, through a rock formation.

Ramp: An inclined tunnel that allows exploration and research of rock features and other phenomena critical to characterizing an underground repository site. It can be used as an entrance to the underground repository should the site prove qualified.

Reinserted fuel: Irradiated reactor fuel that is discharged in one cycle and inserted in the same reactor during a subsequent refueling. In a few cases, fuel discharged from one reactor has been used to fuel a different reactor.

Repository: A site and associated facilities designed for the permanent isolation of high-level radioactive waste and spent nuclear fuel. It includes both surface and subsurface areas, where high-level radioactive waste and spent nuclear fuel-handling activities are conducted.

Reprocessing: The chemical- mechanical processing of irradiated nuclear reactor fuel to remove fission products and to recover fissile and fertile material.

Research reactor: A reactor whose nuclear radiations are used primarily as a tool for basic or applied research. Typically, it has a thermal power to 10 megawatts thermal or less and may include facilities for testing reactor materials.

Single-shell tank wastes: High-level radioactive wastes, generated from defense reactor fuel reprocessing at Hanford, which are stored in single-shelled tanks. These tanks contain inventories of liquid, sludge, and salt cake.

Solvent extraction: The separation of materials of different chemical types and solubilities by selective solvent action.

Special nuclear material: Plutonium or uranium enriched to a higher than natural assay.

Spent nuclear fuel: Nuclear fuel that has been permanently discharged from a reactor after it has been irradiated. Typically, spent fuel is measured in terms of either the number of spent fuel assemblies or the total fuel mass discharged. The latter is measured either in metric tons of heavy metal (i.e., only the uranium and plutonium content of the spent fuel is considered) or in metric tons of initial heavy metal (essentially, the initial mass of uranium and plutonium in the fuel before irradiation). The difference between these two quantities is the weight of the fission products.

Test reactor: A reactor associated with an engineering-scale test program conducted for the purpose of developing basic design information or for demonstrating the safety characteristics of nuclear reactor systems.

Thermal power: A measure of the rate of energy emission that results from the radioactive decay of a material. A unit of thermal power commonly used is the watt (W).
Transmutation: Conversion of radionuclides to shorter-life and more stable isotopes. Usually accomplished by neutron bombardment of radionuclides.

Transuranic waste: As defined by the Department of Energy Order 5820.2A, this is radioactive waste that, at the time of assay, contains more than 100nCi/g of alpha-emitting isotopes with atomic numbers greater than 92 and half-lives greater than 20 years.

Transuranic waste acceptance criteria: A set of conditions established for permitting transuranic wastes to be disposed at the Waste Isolation Pilot Plant.

Transuranic waste certification: The process for verifying that a suspect radioactive waste is transuranic.

Vitrification: The conversion of high-level radioactive waste materials into a glassy or noncrystalline solid for subsequent disposal.

Waste Isolation Pilot Plant: A research and development facility, located near Carlsbad, New Mexico, to be used for demonstrating the safe disposal of wastes from Department of Energy activities.

APPENDIX A

CURRENT WASTE-MANAGEMENT PROGRAMS AND PLANS OF THE OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

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CURRENT WASTE-MANAGEMENT PROGRAMS AND PLANS OF THE OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

The U.S. Department of Energy is legally responsible for managing spent nuclear fuel from civilian sources and disposing of high-level radioactive waste from defense programs. The Department's current program and plans to manage the waste are described in this appendix. This information provides a basis for evaluating the potential effect of additional nuclear waste that could be generated by new commercial nuclear power plants.

Programs and plans for managing the waste are governed by provisions of the Nuclear Waste Policy Act (Public Law 97-425), and by regulations of Federal agencies that have oversight responsibility. Section A.1 describes the requirements and constraints on the program resulting from the Act. Section A.2 describes how the Department is planning to implement these requirements.

A.1 REGULATORY FRAMEWORK OF THE CIVILIAN RADIOACTIVE WASTE MANAGEMENT PROGRAM

A.1.1 Standards Set by the U.S. Environmental Protection Agency and the Nuclear Regulatory Commission

Under Section 121 of the Nuclear Waste Policy Act, the U.S. Environmental Protection Agency sets standards that protect the public and the environment from off-site releases of radioactive materials placed in repositories. The Nuclear Regulatory Commission establishes technical requirements and criteria used to authorize construction and to approve licenses for accepting waste and emplacing it in a repository. The Nuclear Regulatory Commission has the lead in licensing and regulations.

U.S. Environmental Protection Agency Standards

In 1985, the U.S. Environmental Protection Agency set forth standards for managing and disposing of spent nuclear fuel and high-level and transuranic radioactive wastes under 40 CFR Part 191. Although the First Circuit Court of Appeals remanded Subpart B of that regulation, the Environmental Protection Agency is revising it under court review. The Environmental Protection Agency also is involved in a collaborative effort to produce standards for the potential repository at Yucca Mountain, Nevada. In the Energy Policy Act of 1992, Congress asked the Environmental Protection Agency to consult with the National Academy of Sciences, the Nuclear Regulatory Commission, and others to produce standards in three years' time. The National Academy of Sciences will make recommendations concerning the standard. The Environmental Protection Agency will promulgate a regulation. Then, the Nuclear Regulatory Commission will amend 10 CFR Part 60, to reflect specific technical and programmatic requirements for high-level radioactive waste disposal in repositories.

The Resource Conservation and Recovery Act, an amendment to the Solid Waste Disposal Act, was enacted by Congress in 1976 to deal with municipal and industrial solid waste. It was significantly amended in 1984 under the Hazardous Solid Waste Act. Solid waste is subject to hazardous waste requirements if the waste either exhibits hazardous characteristics or falls into listed categories (40 CFR 261.3). The waste producer is responsible for the classification, either by application of materials knowledge, process knowledge, or testing.

There is a potential Resource Conservation and Recovery Act application to Department of Energy produced radioactive mixed waste; this is waste that is both radioactive and hazardous. In defining solid waste, the Resource Conservation and Recovery Act exempts "special nuclear and by-product material" as defined by the Atomic Energy Act of 1954. On May 1, 1987, the Department of Energy issued its interpretive mixed-waste rule, 10 CFR Part 962 (52 FR 15937) providing the Department's final "byproduct material" interpretation for radioactive mixed waste. The Department concluded that the stable, hazardous component of defense radioactive mixed waste is subject to the Resource Conservation and Recovery Act and the radioactive component is subject to the Atomic Energy Act.

The nuclear utilities consider their commercial spent nuclear fuel to be a "by-product material." Additionally, the nuclear utilities, based on process knowledge, have concluded that spent nuclear fuel is not chemically hazardous. Therefore, there is no regulatory reason to treat commercial spent nuclear fuel as hazardous waste under the Resource Conservation and Recovery Act.

With regard to high-level radioactive waste, the producer must characterize waste based on process knowledge or testing as described in the Waste Acceptance System Requirements Document. Currently, the Department is proceeding on the basis that vitrified high-level radioactive waste is not hazardous, relying on limited testing of simulated defense waste glass for Resource Conservation and Recovery Act EP-toxic characteristics.

In June 1990, the Environmental Protection Agency issued a Best Demonstrated Available Treatment Technology determination for vitrified high-level radioactive waste and determined that vitrification would remove hazardous characteristics and immobilize inorganic constituents in the waste. Demonstration of the absence of hazardous characteristics, by testing of vitrified high-level radioactive waste, would allow emplacement of vitrified high-level radioactive waste in a repository without a Resource Conservation and Recovery Act Treatment, Storage, and Disposal Facility Permit.

Nuclear Regulatory Commission Regulations

The Nuclear Regulatory Commission's licensing process is meant to ensure the health and safety of the public. The Commission carries out this charge by developing regulations that specify requirements for a monitored retrievable storage facility and for a geologic repository. The regulations also specify requirements to build and operate the waste-management system; to transport the wastes; and eventually to decommission the repository. The regulations focus on technical requirements for geologic disposal, quality assurance, transportation, storage, environmental standards, and administrative requirements for licensing and the availability of records. State and local governments, Indian Tribes, and other interested parties are free to participate in the licensing process.

For this analysis, the most significant Nuclear Regulatory Commission regulations governing the Civilian Radioactive Waste Management Program are:

- 10 CFR Part 2, Rules of Practice for Domestic Licensing Proceedings and Issuance of Orders. This regulation specifies the licensing process and establishes an electronic system to keep records. It establishes the basic procedures for reviews, hearings, and other licensing proceedings, while safeguarding restricted data and national security information.

- 10 CFR Part 60, Disposal of High-Level Radioactive Wastes in Geologic Repositories. In this regulation, the Nuclear Regulatory Commission specifies technical and program requirements for a repository. Subpart B prescribes the procedural aspects of the licensing application and process throughout the life cycle of a repository. Subpart E sets forth the technical criteria governing the siting, performance objectives, and design of a repository.

- 10 CFR Part 71, Packaging and Transportation of Radioactive Material. This regulation specifies requirements and procedures for packaging and transporting fissile material and other licensed radioactive material. It also mandates following Department of Transportation regulations.

- 10 CFR Part 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste. This regulation specifies the technical and programmatic requirements for short-term nuclear-waste ~~storage facilities.~~ storage in an independent spent fuel storage installation or monitored retrievable storage installation.

- 10 CFR Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, contains a series of rules adopted by the Nuclear Regulatory Commission to evaluate the environmental effects throughout a nuclear power plant's fuel cycle (The Waste Confidence Decision). The rules, refined periodically, find that the long-term permanent storage of spent nuclear fuel will have no significant environmental impact and therefore should not affect the decision to grant a license to a nuclear power plant. They also find that spent nuclear fuel may be stored at a plant safely and without a significant environmental impact for at least 30 years beyond the plant's licensed life of operation. This finding is based on the availability of a permanent disposal facility during the first quarter of the 21st century.

A.1.2 Decision to Emplace Defense Waste with Commercial Waste

Section 8 of the Nuclear Waste Policy Act directed the President to study the need for a separate repository for waste produced and stored by three Department of Energy sites: the Hanford Plant (Washington), the Savannah River site (South Carolina), and the Idaho National Engineering Laboratory site. The Department of Energy evaluated this need for the President and, in 1985, concluded that defense waste may be emplaced along with commercial waste in a repository. The Department of Energy anticipated that initially there would be 20,000 canisters of defense waste to be transported to a repository.

Two cases were considered in the Department of Energy study: (a) separate emplacement of defense and commercial wastes in different repositories, (b) emplacement of defense and commercial wastes in the same repository. The Department of Energy came to the following conclusions:

1. National security considerations did not favor either case. The interim storage capacity is the same in both cases and allows continued defense production and waste immobilization operations in the event of repository-related problems. In neither case is there a need to reveal classified defense information.

2. One repository could be designed for the disposal of both defense and commercial wastes. Regulatory considerations do not favor either case. Certain procedural rules of the Nuclear Waste Policy Act would not apply to a repository that would contain only defense waste. Other regulations do contain similar procedures for defense waste.

3. The two cases have comparable transportation costs and risks.

4. The two cases have comparable effects on health and safety. Both cases would require meeting U.S. Environmental Protection Agency and Nuclear Regulatory Commission regulations.

5. A significant savings would result from constructing, operating, and decommissioning a single repository.

With respect to the issues listed above, the Department of Energy found no drawbacks to emplacing both commercial and defense wastes in one repository.

A.1.3 Finding a Site for the Monitored Retrievable Storage Facility

The Nuclear Waste Policy Act establishes two paths to find a site for a monitored retrievable storage facility: (1) through a survey and evaluation process directed by the Secretary of Energy, or (2) by the Nuclear Waste Negotiator. The Negotiator, appointed by the President, is responsible for locating a volunteering State or Indian Tribe with a technically qualified site for a monitored retrievable storage facility and for negotiating a proposed agreement on reasonable terms. Congress must review the proposed agreement, and, if the Congress approves it, the agreement becomes law.

~~In 1991, the Nuclear Waste Negotiator began an intensive effort to locate a volunteer host and issued a formal request for expressions of interest. More than 21 grant applications have been received and some have been awarded study grants.~~

As of September 1993, the Department has not been able to site a monitored retrievable storage facility. The previous Nuclear Waste Negotiator's resignation was accepted by the Administration in June 1993. While the position of the Negotiator is currently unfilled, the Department continues to support the voluntary siting process and is continuing interactions with the three Phase II grant participants. (The White House has issued a notice of intent to nominate former Idaho Congressman Richard Stallings as Nuclear Waste Negotiator). The Department believes that the voluntary siting process is the best way to site controversial facilities. Even if the voluntary siting process cannot support the January 1998 date for waste acceptance by the Federal government, negotiations will continue with those participants still interested in hosting a monitored retrievable storage facility, with the expectation that a facility will be successfully sited in the future and help alleviate the demands for additional at-reactor storage.

A.1.4 Public Involvement in Activities Related to the Nuclear Waste Policy Act

Public involvement in waste-management program activities is required in the Nuclear Waste Policy Act. The Office of Civilian Radioactive Waste Management involves the public by, for example,

1. consulting with states and Indian Tribes,
2. notifying states and Indian Tribes of siting decisions,
3. providing periods of public review and comment on environmental impact statements and certain Department documents,
4. establishing protocols for interacting with counties, and
5. providing technical assistance.

Financial assistance is extended to State and local governments and Indian Tribes to enable them to participate in overseeing Nuclear Waste Policy Act-related activities. For example, grants are given to eligible jurisdictions to assess the feasibility of hosting the monitored retrievable storage facility and to review repository development. In addition, the Department enters into cooperative agreements involving financial assistance with national organizations that may represent or be able to increase communications with affected parties.

Information is available to the general public. There are fact sheets, brochures, program publications, educational materials, videotapes, and a toll-free telephone information line (1-800-225-NWPA). Public tours of Yucca Mountain site characterization activities are available and there are open houses at the Yucca Mountain project office. A scientific curriculum has been developed for public schools.

A.1.5 Costs and Funding of the Waste-Management Program

The Nuclear Waste Policy Act requires that all Civilian Radioactive Waste Management Program costs be paid by the generators or owners of the waste managed by the program. Costs are allocated to the civilian and defense sectors based on the total estimated cost of the program. The cost-allocation methodology was published in the *Federal Register* in August 1987 and is documented by a report on the total system life cycle cost. After each cost report is published, the Office of Civilian Radioactive Waste Management assesses the adequacy of the current fee structure.

Civilian organizations paid a one-time fee for waste generated before April 7, 1983, and pay an ongoing fee, currently set at one mill per kilowatt-hour, for all nuclear power sold after that date. The Secretary of Energy can propose to Congress that it change the ongoing fee if necessary.

Civilian payments are deposited in the Nuclear Waste Fund, an account in the U.S. Treasury. Congress appropriates funds for the waste-management program each year as part of the Federal budget process. Receipts in excess of current funding needs are invested in interest-earning Treasury securities.

The Energy Department's Office of Environmental Restoration and Waste Management is responsible for costs associated with defense waste. So far, Congress has appropriated $112.5 million for those costs; a formal payment schedule will be negotiated for the remaining obligation. During the interim, interest obligations will continue to accrue on the unpaid balance.

A.1.6 Finding a Site for the Repository

The Nuclear Waste Policy Act requires scientific evaluation of the Yucca Mountain site to determine its suitability for a repository. The program to characterize the site includes surface-based testing and subsurface investigations, which can be conducted in an exploratory studies facility that gives access to a geologic horizon.

An important part of site characterization is a preliminary performance assessment which consists primarily of modeling the behavior of repository systems. The assessment will guide other site characterization studies and will assist investigators in the early evaluation of a site's suitability.

If at any time the Yucca Mountain candidate site is found to be unsuitable for a geologic repository, then ~~all work on the site will cease.~~ site characterization activities will be terminated and the Secretary of Energy will notify the Congress, and the Governor and legislature of Nevada. The Secretary is further required to report to Congress with recommendations for further action.

The DOE directed a contractor to evaluate the suitability of the Yucca Mountain site to meet a commitment made by the Secretary of Energy.[1] The result was an evaluation of the technical suitability of Yucca Mountain as a potential site for a repository[2] focusing on whether any existing features or conditions would render the site unsuitable for repository development. The early site suitability evaluation was the second such evaluation for the Yucca Mountain site; a preliminary site suitability evaluation was completed as part of the site selection process.[3] Both evaluations concluded that the site is suitable for characterization (i.e., that no current scientific or technical reasons to reject the site were identified during the course of the respective evaluations).

The Nuclear Waste Technical Review Board, a Congressionally mandated independent review committee, stated in its recent special report that no site disqualifiers have been identified to date. The Board asserts that "...given the existing data, there appear to be no scientific or technical reasons to reject the site [Yucca Mountain] at this time."[4]

If the Yucca Mountain site is found to be suitable for a repository, the Secretary of Energy will submit a report to the President to recommend development of a repository there. By law, the Department of Energy must comprehensively state the basis of its recommendation. An environmental impact statement must be available to the public. If the President approves, the recommendation will be submitted to Congress. The State of Nevada may then submit a notice of disapproval. Congress can override Nevada's veto.

A.1.7 Report on the Need for a Second Repository

The Secretary of Energy is required by law to study the need for a second repository and report the findings to the President and Congress between January 1, 2007, and January 1, 2010.

A.1.8 Constraints on Storage and Disposal

The Nuclear Waste Policy Act, as amended, restricts the amount of spent nuclear fuel and high-level radioactive waste that can be temporarily stored at one site or that can be permanently placed in a geologic repository:

1. The storage facility cannot be built until the Nuclear Regulatory Commission issues a license to construct a geologic repository.

2. No more than 10,000 metric tons of heavy metal can be stored at the monitored retrievable storage facility with the authorization of the Nuclear Regulatory Commission before the repository begins to accept waste.

3. At no time can more than 15,000 metric tons of heavy metal be stored in the monitored retrievable storage facility.

4. Unless and until a second repository is in operation, no more than 70,000 metric tons of heavy metal can be placed in the first repository.

5. The monitored retrievable storage facility can be constructed neither in Nevada nor within 50 miles of a repository.

These restrictions would not necessarily apply to a monitored retrievable storage facility established pursuant to a negotiated agreement enacted into Federal law.

A.2 THE CIVILIAN RADIOACTIVE WASTE MANAGEMENT PROGRAM

The mission of the Civilian Radioactive Waste Management Program is to manage and dispose of the Nation's spent nuclear fuel and high-level radioactive waste in a manner that protects the health and safety of the public and workers and that protects the quality of the environment. The objectives of the mission are timely disposal capability, timely and adequate waste acceptance, schedule confidence, and system flexibility.

The program has adopted these basic policies: First, the program must assign paramount importance to protecting the health and safety of both the public and workers and to protect the quality of the environment. Second, the program must be conducted so as to warrant public confidence and to ensure that affected governments and interested parties participate in the program in a meaningful way. Third, the program must be distinguished by its technical integrity and excellence and must be directed toward reaching scientific consensus and public understanding. Finally, the program must be managed and conducted in an efficient and cost-effective manner.

A.2.1 Reference Scenario for Planning by the Office of Civilian Radioactive Waste Management

The Office of Civilian Radioactive Waste Management uses a reference scenario for planning. It consists of assumptions regarding the types, amounts, and generation rates of wastes that would require disposal in a repository. The Office plans to accept spent fuel from commercial nuclear power reactors and high-level radioactive waste from four Department sites.

The reference scenario serves as a benchmark in the analysis of other spent nuclear fuel and high-level radioactive waste-generation cases. Some of these cases were evaluated during this study. The reference scenario consists of two cases for high-level radioactive waste and spent nuclear fuel, as explained below.

Energy Information Administration Case for Spent Nuclear Fuel

For planning involving spent nuclear fuel, the Civilian Radioactive Waste Management program uses the most recent no-new-orders case developed by the Energy Information Administration of the Department of Energy as a planning tool. The General Accounting Office recommended that the case be used as a conservative but representative scenario. Based on the no-new-orders case, approximately 85,700 metric tons of heavy metal of spent nuclear fuel will be discharged by commercial nuclear power plants through the year 2030.

Integrated Data Base Case for High-Level Radioactive Waste

The Office of Civilian Radioactive Waste Management assumes that high-level radioactive waste will be solidified in metal canisters at the West Valley Demonstration Project, the Savannah River site, the Idaho Chemical Processing Plant, and the Hanford site. These assumptions regarding the types and amounts of high-level radioactive waste and the rates at which high-level radioactive waste will be generated are founded primarily on the Integrated Data Base prepared by the Oak Ridge National Laboratory.

Based on the assumptions regarding high-level radioactive waste given in two recent program documents based on the 1988 Integrated Data Base and several other assumptions by the Office, 300 canisters will be generated at the West Valley site. In addition, 17,750 canisters will be produced by the other three. Projections in the 1988-1991 versions of the Integrated Data Base were the same. Projections in the 1992 Integrated Database, however, were significantly different. Based on the 1992 projections, 300 canisters will be generated by the West Valley site, and 13,600 canisters will be generated at the Savannah River and Idaho sites, and all sources other than the single-shell tanks at the Hanford site. An additional 10,000 to 35,000 canisters will come from waste in single-shell tanks at the Hanford site. In this case, it is assumed that the Hanford site will produce 10,000 canisters. The generation of 35,000 canisters is an assumption of another waste-generation case described in Section 4.

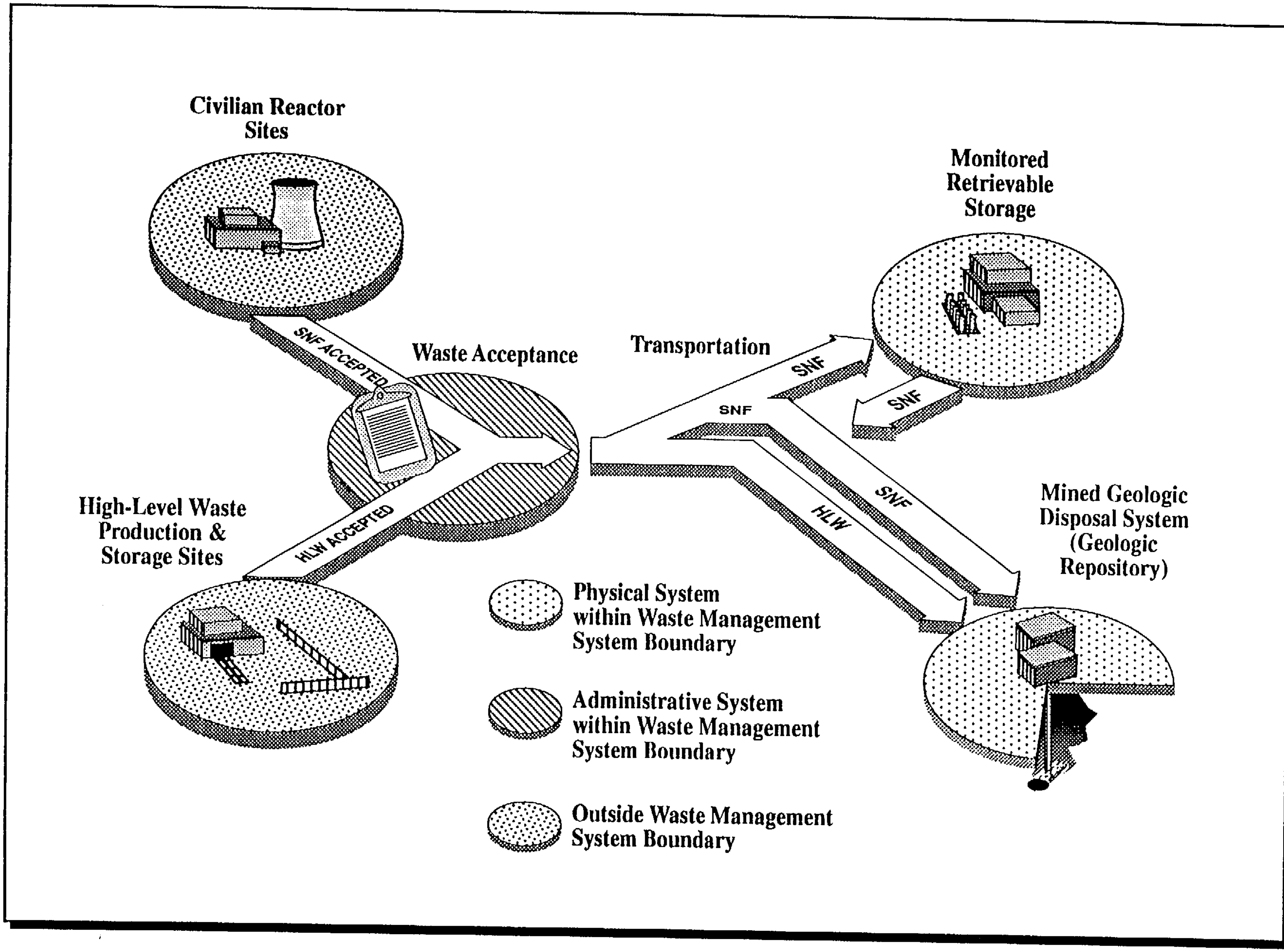
A.2.2 <u>The Waste-Management System</u>

Development of the Waste-Management System

The waste-management system (Figure A-1) is in an early stage of development; many designs are being studied. For example, recent studies cite the benefits of standardized canisters. These canisters maybe loaded with spent nuclear fuel and sealed at reactor sites. Once sealed, the multi-purpose canisters may be stored, transported and disposed of without being reopened. The program will continue the development of a design for standardized canisters to support spent nuclear fuel transportation, storage, and disposal.

Acceptance of Waste for Disposal

The Department of Energy is required to accept for disposal from owners and generators all spent nuclear fuel and high-level radioactive waste, as provided in Section 302 of the Nuclear Waste Policy Act. Civilian owners and generators of spent nuclear fuel and/or high-level radioactive waste are required to execute a contract with the Department of Energy, consistent with the "Standard Contract for the Disposal of Spent Nuclear Fuel and/or High-Level



Civilian Reactor Sites
Monitored Retrievable Storage
SNF ACCEPTED
Waste Acceptance
Transportation
SNF
SNF
SNF
SNF
HLW
HLW ACCEPTED
High-Level Waste Production & Storage Sites
Mined Geologic Disposal System (Geologic Repository)
Physical System within Waste Management System Boundary
Administrative System within Waste Management System Boundary
Outside Waste Management System Boundary

Figure A-1

Radioactive Waste" (10 CFR Part 961). Federal agencies or departments requiring the Department of Energy's disposal services for spent nuclear fuel and/or high-level-radioactive waste will be accommodated by an interagency agreement reflecting, as appropriate, the terms and conditions set forth in the Standard Contract. To date, no interagency agreements have been executed.

The waste-acceptance process begins with purchasers providing the Office of Civilian Radioactive Waste Management with information concerning the quantities and characteristics of the waste currently in inventory. These characteristics include the date on which the spent nuclear fuel was permanently discharged. Purchasers also provide the Office of Civilian Radioactive Waste Management with projections of the waste that will be generated during future operations.

In accordance with the Standard Contract, an annual Acceptance Priority Ranking report and an Annual Capacity Report are issued. The Acceptance Priority Ranking establishes the order in which we allocate projected spent nuclear fuel acceptance capacity. As required by the Standard Contract, the priority ranking is based on the date the spent nuclear fuel was permanently discharged, with the owners of the oldest spent nuclear fuel, on an industry-wide basis, given the highest priority.

The 1991 Acceptance Priority Ranking is the basis for allocating spent nuclear fuel acceptance capacity to each owner in the 1991 Annual Capacity Report. The Annual Capacity Report applies a 10-year projected waste acceptance rate to the Acceptance Priority Ranking, resulting in individual capacity allocations. An allocation is a specified acceptance capacity, measured in metric tons in a particular year for an individual purchaser.

The allocations in the 1991 Annual Capacity Report are the basis for Delivery Commitment Schedule submittals, which represent the next step in the spent nuclear fuel acceptance process outlined in the Standard Contract. The Delivery Commitment Schedule provides the purchasers with the opportunity to inform the Department of Energy of their plans for utilizing their allocations of projected spent nuclear fuel acceptance capacity. This information will assist the Office of Civilian Radioactive Waste Management in meeting its contractual waste-acceptance responsibilities and in developing the waste-management system.

The Standard Contract states that, beginning January 1, 1992, purchasers may begin submitting Delivery Commitment Schedules for Department of Energy approval. The Schedules identify all spent nuclear fuel the purchasers plan to deliver to the Department of Energy beginning 63 months thereafter. A Delivery Commitment Schedule is submitted for only one designated delivery site and only one fuel type (boiling-water reactor, pressurized-water reactor, or other reactor). Both the purchaser's and Department's ability to commit to a specific delivery date over 63 months in the future is limited. Therefore, only the year of delivery is designated on the Delivery Commitment Schedule. The Delivery Commitment Schedule also includes information concerning the proposed transport mode and the range of permanent discharge dates for the fuel to be delivered.

After a Delivery Commitment Schedule has been approved, purchasers may either use the Delivery Commitment Schedule as the reference document for submittal of the Final Delivery Schedule, which is required 12 months prior to delivery, or use the Delivery Commitment Schedule as the basis for exchanges with other purchasers. The Final Delivery Schedule is more specific with regard to the spent nuclear fuel to be delivered. The actual date of delivery will be proposed by the purchasers in their Final Delivery Schedule submittal.

Waste Transportation

The Department of Energy is developing a system to transport spent nuclear fuel and high-level radioactive waste. The functional requirements baseline of the transportation system is the basis of the design and development.[5] The spent nuclear fuel and high-level radioactive waste will be transported from the sites of purchasers (i.e., utilities or other commercial spent nuclear fuel owners or producers, and commercial and defense high-level radioactive waste generators) to one or more federal waste-management facilities in packages certified by the Nuclear Regulatory Commission, as required by Section 180(a) of the Nuclear Waste Policy Act. Spent nuclear fuel will be shipped by truck, rail, or barge, or by a combination, from the purchasers' sites to the monitored retrievable storage facility or directly to the repository, depending on the location of the spent nuclear fuel storage site and the monitored retrievable storage facility. Spent nuclear fuel will be shipped from the monitored retrievable storage facility to the repository by rail in dedicated trains. All high-level radioactive waste will be shipped directly by rail from the producers' storage sites to the repository. The Department of Energy will manage and monitor traffic in the system and maintain cask systems for transportation of spent nuclear fuel and high-level radioactive waste.

Transportation casks will be designed to protect the public and workers and to contain nuclear waste even if a serious accident occurs (Figure A-2).

Four types of casks will be required for the transportation system: (1) "from-reactor casks" suitable for shipping 80 to 85 percent of the spent nuclear fuel to either the monitored retrievable storage facility or a repository; (2) "from-monitored-retrievable-storage-casks" suitable for shipping spent nuclear fuel from the monitored retrievable storage facility to a repository; (3) "specialty casks" suitable for shipping the remaining spent nuclear fuel not held by "from-reactor casks"; and (4) "high-level radioactive-waste casks" suitable for shipping commercial and defense high-level radioactive waste from storage to the repository.

The reference transportation system is sized to support the reference waste acceptance rates as follows:

- Reactors to monitored retrievable storage facility: An initial rate of 400 metric tons of uranium spent nuclear fuel per year in 1998 increases to about 900 metric tons of uranium by 2000. It stays at that level until 2010. The rate then increases until it reaches nearly 3,000 metric tons of uranium spent nuclear fuel per year in 2013. Spent nuclear fuel acceptance continues at this rate until 2028.

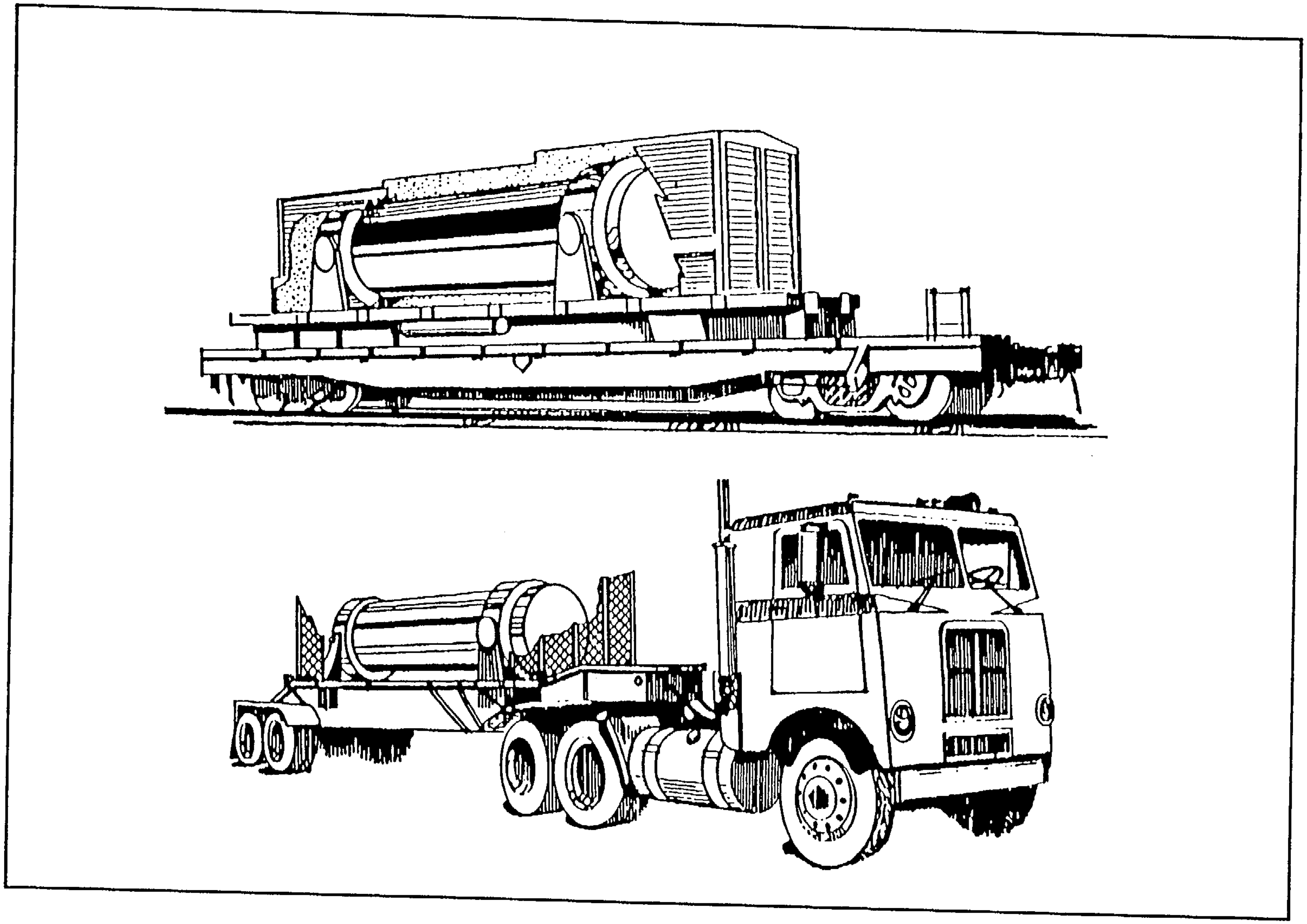


Figure A-2
Artist's Rendering of Rail and Truck Casks

- Monitored retrievable storage facility to the repository system: Starting in 2010, a rate of about 300 metric tons of uranium spent nuclear fuel per year increases to 3,000 metric tons in 2014. Spent nuclear fuel acceptance continues at this rate until 2033, when all of the 63,000 metric tons of uranium spent nuclear fuel accepted has been emplaced in the repository.

- High-level radioactive waste to geologic repository: An initial rate of 400 metric tons of uranium equivalent per year starting in 2015 continues until 2032, when 7,000 metric tons of uranium equivalent has been received.

The Office of Civilian Radioactive Waste Management is developing only from-reactor cask systems. The development of from-reactor casks has two phases. Phase 1 is designed to satisfy the near-term transportation needs of the system by using existing technology casks, including casks currently licensed by the Nuclear Regulatory Commission, modifications of those casks, and new designs that use materials and concepts already licensed by the Nuclear Regulatory Commission. Both truck and rail or barge casks will be procured from private industry during phase 1. Procurement specifications and requests for proposals are being developed to ensure phase 1 cask systems are delivered in time for the start of shipping spent nuclear fuel to the monitored retrievable storage facility.

Phase 2 is designed to meet the long-term needs of the transportation program. A new generation of high-capacity casks will be developed. By taking advantage of the longer time to cool spent nuclear fuel, reduced radiation levels, and technological advancement, the phase 2 casks will increase the payload three to four times more than currently licensed casks. This payload increase will reduce the number of shipments, reduce exposure, and improve efficiency. A legal-weight truck cask system and a rail or barge cask system are currently under development.

Another major element of the transportation system is the support and operations system, which includes activities such as maintenance facilities, auxiliary equipment, and service and operations personnel needed to ensure safe and predictable transportation of spent nuclear fuel and high-level radioactive waste. The priorities for waste acceptance and transportation and the respective responsibilities of the purchasers and the Federal government regarding the loading of transport packages are defined in the Standard Contract with the purchasers. The transport of defense high-level radioactive waste is not covered by the terms and conditions of the Standard Contract. However, a memorandum of agreement will be developed between the Office of Civilian Radioactive Waste Management and the Office of Environmental Restoration and Waste Management.

Institutional activities are also a major element of the transportation system. Federal law requires that the Department of Energy provide technical assistance and funding to states for training public safety officials in the procedures for safely handling spent nuclear fuel and high-level radioactive waste and for emergency responses. A strategy and options for providing this assistance have been published.

Storage of Waste in the Monitored Retrievable Storage Facility

The Department of Energy plans to ~~will~~ site, construct, and operate one monitored retrievable storage facility, as authorized by Section 142(b) of the Nuclear Waste Policy Act and according to the monitored retrievable storage functional requirements baseline.[6] If sited, the Department will temporarily store in the monitored retrievable storage facility up to 15,000 metric tons of spent nuclear fuel from civilian owners and generators. Once stored, the spent nuclear fuel will be continuously monitored and safely maintained. The facility will be designed so that the spent nuclear fuel can be readily retrieved for disposal in a geologic repository.

In 1992, the Department of Energy ~~recently~~ completed a ~~the~~ conceptual design for ~~of~~ the monitored retrievable storage facility to demonstrate its technical feasibility, to establish technical performance measures, and to develop cost and schedule estimates[7] (Figure A-3). Requirements include compliance with regulations and licensing requirements, as well as compatibility with the transportation and repository systems.

The design includes plans for receiving, handling, packaging, and storing spent fuel and for support and industrial services. Six storage concepts were considered in developing the monitored retrievable storage facility conceptual design, and a complete design was developed for each concept. Each design was evaluated to determine feasibility, cost, relative operational risks, and the time needed for construction. Four of the designs are based on using dry transfer and storage for the spent fuel. One is based on using a water pool for transfer and storage. Another design is based on using a transportable storage cask that requires no routine transfer of fuel and provides dry storage.

The Office of Civilian Radioactive Waste Management considers all six designs to be acceptable and feasible. The choice will be made after a facility site has been found and will depend on licensing, cost, and schedule considerations and on the preferences of the volunteer host. The Office of Civilian Radioactive Waste Management considers the selection of the specific storage technology used at the monitored retrievable storage facility to be a joint effort between the Department and the host. The choice of storage technology will be made after the facility site has been identified and will depend on licensing, cost, and schedule considerations and on the preferences of the volunteer host.

~~The conceptual design is not the final design of the monitored retrievable storage facility. It is the first step in a three-step process. The second step is to prepare a more detailed design to be submitted to the Nuclear Regulatory Commission as a safety analysis report, which is a comprehensive description of the facility and proposed operations.~~ If the Department is successful in finding a volunteer host for the monitored retrievable storage facility, additional steps must be taken to complete the design, licensing and construction of the facility prior to operation. After the completion of conceptual design, the second step is to prepare a more detailed design

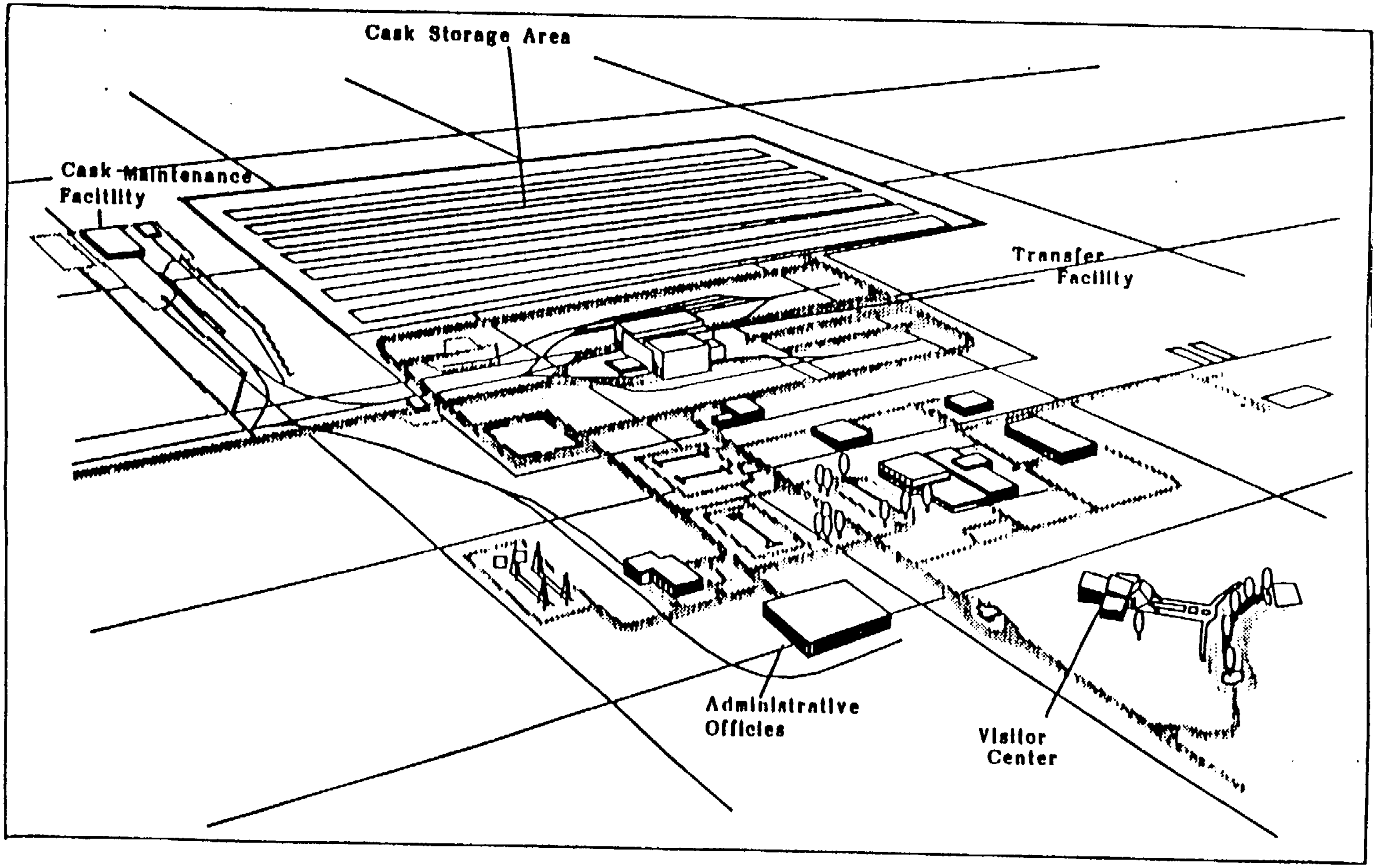


FIGURE A-3
Conceptual Drawing of a Monitored Retrievable Storage Facility

to be submitted to the Nuclear Regulatory Commission as a safety analysis report, which is a comprehensive description of the facility and proposed operations. The report will include a safety analysis of the monitored retrievable storage facility under both normal conditions and natural hazards (e.g., earthquakes, tornadoes, lightning strikes, fire) or accidents that could occur at the facility. The safety analysis will include the detailed, final design information on all safety-related systems and components of the facility. The last step of the monitored retrievable storage design will be procurement and construction design. It will differ from the license application design in that it will give more detailed information on support and auxiliary systems.

More recently, the Department has undertaken an evaluation of incorporating a multi-purpose canister into the interim storage strategy until either the monitored retrievable storage facility or the repository can be sited, constructed and placed into operation. Several potential advantages of the multi-purpose canister over the currently considered monitored retrievable storage/transportation system include:

- Compatibility and standardization throughout the Civilian Radioactive Waste Management System, which could lead to reduced handlings and increased radiological safety.
- Early relief to utilities through availability of multi-purpose canisters for at-reactor storage in the event of delayed waste acceptance.
- Simplified facilities at both the monitored retrievable storage facility and the repository, which could reduce cost and radiological risk.
- More positive public perception of a system in which fuel is handled in sealed canisters. The multi-purpose canister concept is further described in the following section.

Multi-Purpose Canisters

The Department has initiated a study to develop a standardized multi-purpose canister that is suitable for the Federal waste management system and compatible with at-reactor storage. The multi-purpose canister is a sealed metal canister designed for the storage, transportation, and disposal of spent fuel. It is intended to be used in conjunction with separate overpacks designed for appropriate functions. The multi-purpose canister will be shielded on the top, to facilitate sealing and handling, but not shielded on the sides or bottom. Supplemental shielding will be provided by the overpacks. Once loaded with spent fuel, the multi-purpose canister will not be transported, stored, or handled outside a shielded overpack, transfer system, or facility.

The multi-purpose canister would be used at reactor sites for both onsite dry storage and for transportation from the site. Facilities that are unable to use multi-purpose canisters, for handling or infrastructure reasons, will load uncanistered spent fuel assemblies into truck casks for shipment to the monitored retrievable storage facility or repository.

The monitored retrievable storage facility conceptual design mentioned in the previous section, has been reviewed with respect to potential changes that would be required to handle multi-purpose canisters. This review has led to a modified design of a facility capable of handling both multi-purpose canisters and bare spent nuclear fuel. Transportation cask maintenance services are integrated into the same facility. The final Multi-Purpose Canister Implementation Program Conceptual Design Phase I Report will contain, not only multi-purpose canister design information, but also the modified monitored retrievable storage facility design for handling multi-purpose canisters.

Disposal of Waste in the Geologic Repository System

A geologic repository will be constructed to isolate spent nuclear fuel and high-level radioactive waste from the accessible environment. The repository will be designed so that the spent nuclear fuel and high-level radioactive waste can be retrieved from it, if necessary.

The repository system will have three components, each providing barriers needed to isolate radioactive materials. These components are the natural system, the repository itself, and the waste package. The natural system is the host rock in which the repository will be constructed and the surrounding rock as well as other natural occurrences. The repository consists of underground facilities, surface facilities, and shafts and ramps for ventilation and access. The underground facilities are mined-out rooms where spent nuclear fuel and high-level radioactive waste will be emplaced. It includes related components, such as those needed to seal access openings and to backfill the mined-out rooms if necessary.

In the surface facilities of the repository, spent nuclear fuel or high-level radioactive waste will be received, inspected, and prepared for permanent disposal. The surface facilities will also support ventilation, utilities, and administration.

The waste package consists of the waste form (spent nuclear fuel or high-level radioactive waste), the disposal container, and shielding, packing, and other material immediately surrounding the container.

Design of the Repository

Conceptual designs of the repository and the waste package were completed for the Site Characterization Plan (Figure A-4). The next phase of the repository system design process is the advanced conceptual design, which will be followed by the license application design and the final procurement and construction design.

The objective of the advanced conceptual design is to develop appropriate solutions to the design-related licensing issues identified by consulting with the Nuclear Regulatory Commission. Major activities related to advanced designs of the repository will be emphasized as information about the site becomes available.

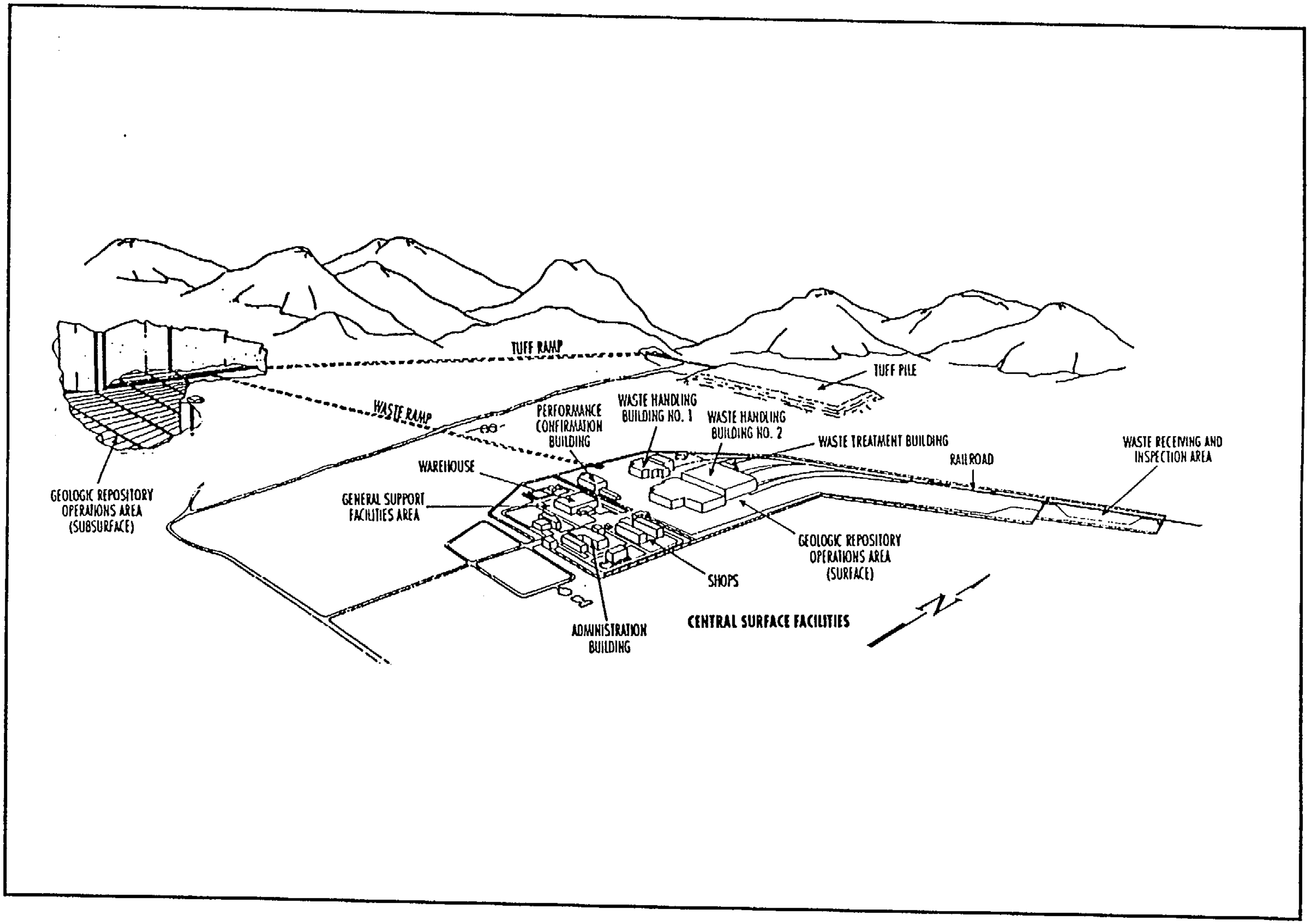


Figure A-4
Conceptual Drawing of a Geologic Repository

The license application design will resolve the design and licensing issues identified during earlier design phases. Also, the Department of Energy will design items necessary to demonstrate compliance with safety and isolation requirements and performance objectives of 10 CFR Part 60. Sufficient design information will be developed during this phase to meet the requirements of the license application. Design requirements resulting from a detailed safety and reliability analysis will be fully integrated with the license application design. This information will be used to prepare the safety analysis report. Site characterization data and their effect on the design process will be continually reported during the design phases.

Accurate knowledge of the repository site's characteristics is crucial not only to assess repository performance but also to develop a safe design that accommodates the natural features of its environment. These activities are performed in accord with Section 113(c)(1) of the Nuclear Waste Policy Act and the requirement document for the waste-management system.[8] Information from the site characterization program will be used to determine the

1. area needed for waste storage;
2. orientation, layout, and size of underground facilities;
3. ground support components for shafts, drifts, and ramps;
4. openings that provide stability under sustained thermal loading;
5. layout of the groundwater drainage system; and
6. design of the ventilation system.

For procurement and construction, the Department of Energy will develop final drawings and specifications. This phase will emphasize completion of the design of ancillary support items, the refinement of items needed to demonstrate compliance with the design criteria and performance objectives of 10 CFR Part 60, the development of construction bid packages for all systems, and the development of final construction and procurement schedules.

Performance assessments will be done to determine whether the design of the repository will meet the requirements placed on the behavior of the repository system. Estimates of uncertainties will be considered in design and changes.

Capacity of a Repository

Three factors could influence the total nuclear waste capacity of a geologic repository: the space available, the thermal-mechanical properties of the rock, and the heat-generating characteristics of the waste at time of its emplacement in the repository.

The space available in the repository depends on several factors, such as (1) the extent of the geological feature in which the repository is to be constructed, (2) the required distance between the land surface and the repository horizon, (3) the required thickness of the geological section, (4) the required distance between the potential repository horizon and the water table, (5) the juxtaposition of the repository and geological features, and (6) the locations and characteristics of faults within and around the repository area.

The Department of Energy is conducting a thermal-loading system study in order to select a strategy for the potential repository at Yucca Mountain, Nevada. Radioactive wastes produce heat for thousands of years after they are placed in a repository, therefore the amount of waste that could be emplaced will depend on the chosen thermal-loading strategy for the repository.

The final thermal-loading strategy for the repository has not been chosen. The Nuclear Waste Technical Review Board reported that, with lower thermal loadings, rock properties may be more predictable. Another theory is that long-term high thermal loading would prevent some corrosion of waste packages, reducing the release of radionuclides.[9]

The rate at which radioactive waste generates heat depends on its burnup and age at the time of emplacement. This factor, in addition to the thermal-loading strategy and the area available for waste, would affect the waste capacity. The amount of heat generated by spent nuclear fuel decreases significantly in the first 50 to 100 years after it is removed from a reactor core. Consequently, proposed waste packages for older fuel assemblies could be more closely spaced in the repository and still achieve the desired thermal loading.

A.2.3 Schedule for the Waste-Management System

Schedule for the Geologic Repository

The schedule for first repository development is only an estimate and will not be finalized until site characterization is completed.

The schedule for geologic repository development used in this analysis (Figure A-5) is based on the following assumptions:

- Site characterization will be successful, and the Nuclear Regulatory Commission will approve the license application.
- The Department of Energy will begin to construct the repository as soon as the Nuclear Regulatory Commission approves the final license application.
- It will take five years to build the surface facilities.
- Underground facilities will continue to be built while spent nuclear fuel and high-level radioactive waste are emplaced in the repository.

The Department of Energy will operate the repository for approximately 50 years. Materials will be emplaced during the first 35 years, and then the repository will be closed and decommissioned during the next 15 years. The time required for closure will depend on the extent of excavation during construction of the repository and other factors. It will take five years to decommission the repository. Section 801(c) of the Energy Policy Act of 1992 requires the Secretary of Energy to continue to oversee the repository after its closure.

Schedules for the Monitored Retrievable Storage Facility and the Multi-Purpose Canister System

~~Once the future site of the monitored retrievable storage facility is identified, the Department will prepare the safety analysis report design, the environmental impact statement, the final procurement and construction design, and a license application. These items will be reviewed~~

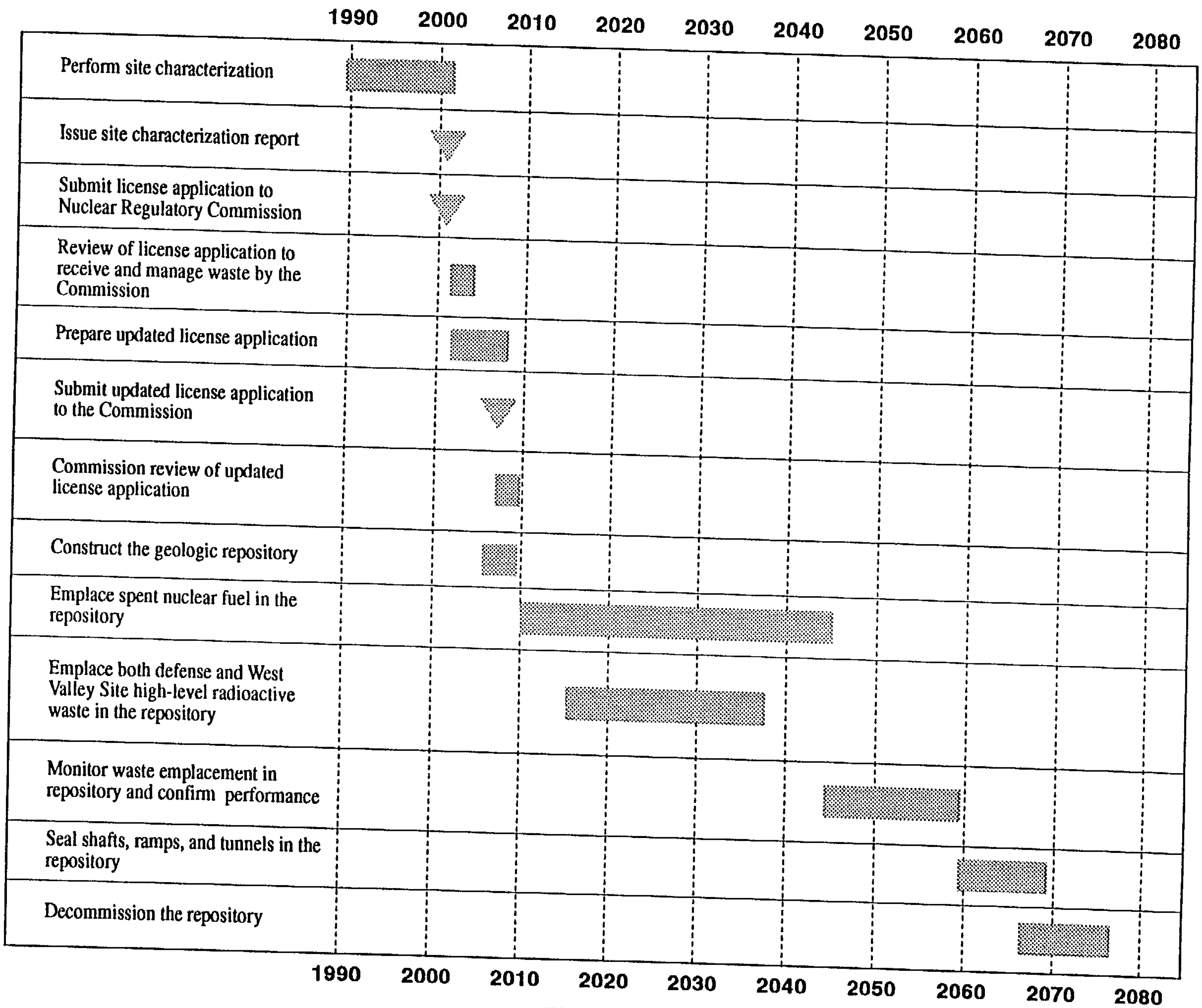


Figure A-5
Schedule for the Geologic Repository

~~by the Nuclear Regulatory Commission. Once the Commission has issued the license, the Department will construct the facility within three years (Figure A-6).~~

If a monitored retrievable storage facility site is identified by the end of 1994, the facility could be ready to begin receipt of spent nuclear fuel by January 2000. Activities leading up to the license application for the monitored retrievable storage facility by the Department are preceded by completion of a environmental assessment, preliminary design (referred to as the safety analysis report design), final design (referred to as the final procurement and construction design) and an environmental impact statement. Review of the monitored retrievable storage facility license application by the Nuclear Regulatory Commission is expected to take 1 1/2 years. Once the Commission has issued the license, the Department can construct the facility within three years (Figure A-6).

If the multi-purpose canister concept is implemented, it is anticipated that the Federal government could have multi-purpose canisters available for at-reactor storage beginning in 1998. Activities leading up to deployment of the multi-purpose canister include the development of an environmental assessment, an acquisition strategy that uses vendors to design and license the multi-purpose canister/transportation system, and multi-purpose canister procurement through either the Federal government or through the utility.

Schedule for the Transportation System

The Department of Energy will begin to operate the transportation system when the monitored retrievable storage facility is ready to store spent nuclear fuel. The system will operate for 50 years. About five years before the first wastes are to be shipped to the facility, the Department will start to construct transportation support systems and to procure

- different casks needed to ship spent nuclear fuel by rail or truck,
- casks needed to transport spent nuclear fuel from the monitored retrievable storage facility to the geologic repository, and
- casks needed to transport radioactive materials from defense sites to the repository.

The last two types of casks will be procured just before the wastes are transported to the repository. The procurement schedule for shipping casks will depend on the rate that the casks are used and on schedules to accept radioactive materials into the waste-management system. The Nuclear Regulatory Commission will take two years to review each cask design.

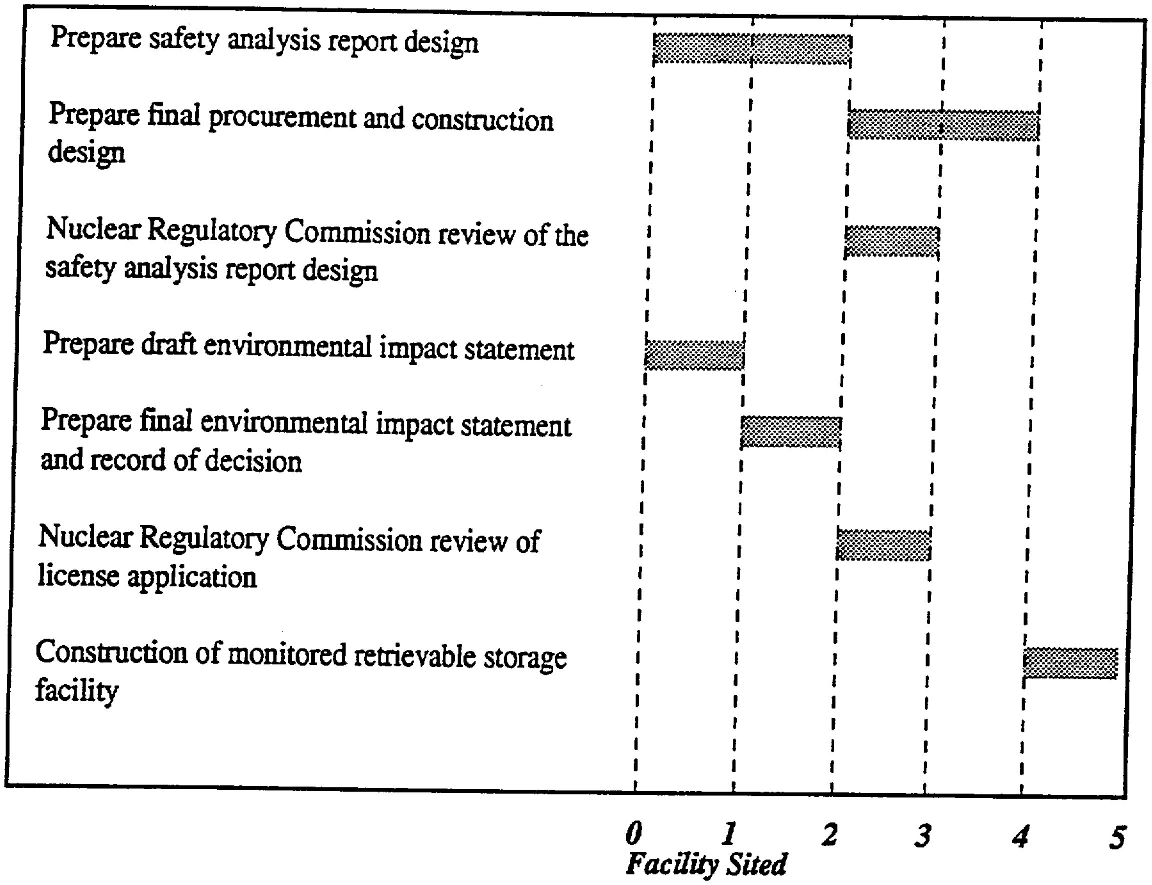


Figure A-6
Schedule for the Monitored Retrievable Storage Facility

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APPENDIX B

DESCRIPTION OF PARTITIONING-TRANSMUTATION PROCESSES AND WASTE MATERIALS

APPENDIX B

DESCRIPTION OF PARTITIONING-TRANSMUTATION PROCESSES AND WASTE MATERIALS

The partitioning and transmutation case assumes that all start-up and make-up fuel for advanced liquid-metal reactors will be produced by pyroprocessing spent nuclear fuel from light-water reactors (Section 5.3.1). This appendix provides descriptive information about two technologies - advanced liquid-metal reactors and pyroprocessing - upon which the partitioning and transmutation case (Section 5) is based, and describes how the volumes of waste presented in the partitioning and transmutation case were calculated.

B.1 ACTINIDE-BURNING ADVANCED LIQUID-METAL REACTORS

In any operating reactor, neutron-capture reactions result in the formation of various transuranic actinide elements; these include the minor actinides (principally americium, curium, and neptunium) as well as plutonium. Because of their relatively low absorption cross sections for thermal neutrons, these elements accumulate to significant levels in the spent nuclear fuel from light-water reactors. The actinides are also highly toxic and long-lived.

Unlike light-water reactors, advanced liquid-metal reactors operate on a fast (high-energy) neutron spectrum and therefore can efficiently use as fuel the transuranic actinides, which have relatively high fast neutron absorption cross sections. Advanced liquid-metal reactors are therefore able to both produce energy and consume actinides which would otherwise require disposal in a repository. The design of liquid-metal reactors can be altered to produce different ratios of plutonium production to depletion, permitting either a net consumption ("burning") or a net production ("breeding") of actinides. Only actinide-burning advanced liquid-metal reactors are considered in the partitioning and transmutation case discussed in Section 5.

Each advanced liquid-metal reactor will undergo numerous refueling cycles during its lifetime. Since only a fraction of the actinide fuel is actually consumed by fission during each cycle, the spent fuel may be reprocessed in order to extract the remaining actinides. These are then recycled into new advanced liquid-metal reactor fuel. For the actinide-burning reactors discussed in Section 5, additional transuranic material, or make-up fuel, must be supplied in each refueling cycle to replace the actinides consumed during reactor operation. These actinides can be obtained by reprocessing spent nuclear fuel discharged by light-water reactors or from recycled defense materials.

B.2 PYROCHEMICAL REPROCESSING

Pyrochemical reprocessing, or pyroprocessing, is a means of reprocessing spent nuclear fuel which uses high temperatures and molten salt and molten metal solvents to electrolytically separate the fission product and actinide fractions of spent fuel. Further electrolytic processes are then used to separate uranium from the transuranic actinides. This process was first developed for use in reprocessing the metallic fuels planned for use in advanced liquid-metal reactors. The process results in extraction of the transuranic elements in a metallic form which is suitable for fabrication into new advanced liquid-metal reactor fuel without further chemical conversion steps.[1] This basic pyrochemical extraction process is described in several recent studies.[2,3,4]

Pyroprocessing technology has been successfully demonstrated at an engineering scale using advanced liquid-metal reactor metallic fuel materials. Process descriptions and flowsheets have also been developed for the pyroprocessing of light-water reactor spent fuel.[2,5]

B.3 WASTE PACKAGES

Waste packages of various dimensions have been suggested to hold the wastes resulting from pyroprocessing of both light-water reactor and advanced liquid-metal reactor spent nuclear fuels. The capacities of these packages range from 18 to 39 cubic feet of waste. (By comparison, the waste canisters for high-level radioactive waste described in Section 4.1 would each hold about 31 cubic feet of waste.) Tables B-1 and B-2 show ranges in the numbers of possible waste packages, based on the different-sized packages assumed in various published studies. Not all of these packages have been thoroughly evaluated, and some may ultimately prove unsuitable for repository use due to high thermal outputs or other factors. They are used here, however, to illustrate the likely upper and lower bounds on numbers of waste packages expected from the partitioning and transmutation case.

B.4 WASTES GENERATED FROM PYROPROCESSING OF LIGHT-WATER REACTOR SPENT NUCLEAR FUEL

Waste streams considered in the partitioning and transmutation case include all materials which are currently expected to require repository disposal; that is, both greater-than-Class-C wastes and high-level wastes. This section and those following describe the wastes produced by the two applications of pyroprocessing in the partitioning and transmutation case: pyroprocessing of light-water spent nuclear fuel, and pyroprocessing of advanced liquid-metal reactor spent nuclear fuel.

B.4.1 Description

Pyroprocessing of light-water reactor spent nuclear fuel is assumed to use the salt-transport process which is described in several recent studies.[2,4,6] This process results in the extraction of uranium and the transuranic elements (chiefly plutonium, americium, curium, and neptunium) in a metallic form which may be used to fabricate new advanced liquid-metal reactor fuel. A separate uranium metal stream is also produced.

Table B-1

Wastes Requiring Repository Disposal
Produced by the Pyroprocessing of Light-Water Reactor Spent Nuclear Fuel

Type of Waste	Matrix	Waste Packages per 1,000 Metric Tons of Light-Water Reactor Spent Nuclear Fuel Reprocessed
Metal wastes, including fuel and assembly hardware, transport metal, electrorefiner metal, and other process wastes such as anode baskets, crucibles, fume traps, and other wastes.	Copper metal; hardware may be packaged separately with no other matrix material.	90-244
Salt wastes, including reduction salt, transport salt, and electrorefiner salt.	Zeolite	165-494
Gases (primarily tritium, carbon-14, and iodine-129).	Molecular sieves or AgI	0-13
Total number of waste packages per 1,000 metric tons of heavy metal		255-751
Total number (rounded to nearest 100) of waste packages for 36,200-54,800 metric tons of heavy metal[a]		9,200-41,200[b]

Source: References 6 and 7.

(a) Estimated quantity of light-water reactor spent fuel that would need to be reprocessed to supply all fuel requirements for advanced liquid-metal reactors by 2030.

(b) This case also produces 21 to 79 waste packages of noble gases (primarily krypton-85 and xenon-131) per 100 metric tons of spent nuclear fuel processed. These are not included in the total in this table because they are in a compressed-gas form, which is not suitable for repository disposal.

Table B-2

Waste Resulting From the Pyroprocessing of Spent Nuclear Fuel From Advanced Liquid-Metal Reactors

Type of Waste	Matrix	Waste Packages per 100 Gigawatt (electric)-years
Electrorefining salt	Zeolite	153-1,855
Fuel hardware (cladding hulls) and electrorefining metal	Copper	92-727
Total waste packages per 100 gigawatt (electric)-years		245-2,582
Total waste packages (rounded to nearest 100) for 167-191 gigawatt (electric)-years[a]		400-4,900[b]

Source: References 7, 8, and 12.

(a) Expected power production from all advanced liquid-metal reactors by 2030.

(b) Fifty-three waste packages of compressed noble gases (primarily krypton-85 and xenon-131) per 100 gigawatt (electric)-years are also produced by the pyroprocessing of advanced liquid-metal reactor spent nuclear fuel. These are not included in the totals because the compressed-gas waste form is unsuitable for repository disposal.

The wastes resulting from the pyroprocessing of light-water reactor spent nuclear fuel have been categorized differently by various studies. When these wastes are separated according to the steps in the pyrochemical process, the following waste streams may be identified: [4,6,7]

- Fuel and assembly hardware, consisting of zircaloy cladding hulls and other stainless steel hardware, that contains activation products such as carbon-14 and radioactive isotopes of nickel, as well as residual actinides.

- Reduction salt waste containing calcium salts used in the pyrochemical process together with the fission products strontium, cesium, yttrium, barium, and rubidium.

- Transport salt waste consisting of magnesium chloride salt used in the pyrochemical process together with the fission products samarium and europium.

- Transport metal waste consisting of copper used in the pyrochemical process, technetium-99 and other fission products, and radioactive isotopes of tin, zirconium, and other metals.

- Electrorefiner salt waste consisting of lithium and potassium salts used in the pyrochemical process together with the same fission products found in the reduction salt waste.

- Electrorefiner metal waste containing primarily europium-154 and radioactive isotopes of tin and other metals, together with process wastes such as anode baskets, crucibles, and fume traps.

- Noble gases, primarily the fission products krypton-85 and xenon-131.

- Other gases, such as carbon-14, tritium, and iodine-129.

These wastes may be either packaged separately or combined into "salt waste" and "metal waste."

Noble gases, primarily the fission products krypton-85 and xenon-131, are also produced as waste during the pyroprocessing of light-water reactor spent nuclear fuel. These gases could be collected and compressed for storage, but their ultimate disposition has not been determined. Some researchers suggest placing these short-lived radionuclides in a surface storage facility until they have decayed to negligible levels.[6,8] Others suggest the disposal of these wastes in a repository specifically designed for them.[7] However, existing regulations prohibit the repository disposal of compressed-gas waste forms. Therefore, estimated quantities of compressed-gas waste are not included in the total waste volumes calculated for the partitioning and transmutation case.

The assumed matrix materials for wastes which would be disposed of in a geologic repository are as follows:

- Metal wastes, including fuel and assembly hardware, transport metal, electrorefiner metal, and other process wastes such as anode baskets, crucibles, fume traps, and other items, are assumed to be commingled and contained in a copper metal matrix. Alternatively, the fuel and assembly hardware could be packaged separately with no matrix material.

- Salt wastes, including reduction salt, transport salt, and electrorefiner salt, are assumed to be contained in a compacted zeolite form. (Because of their high solubilities, containment and immobilization of the salt wastes are difficult and remain the subject of active research.)

- Gases such as tritium, carbon-14, and iodine-129 may be either collected in appropriate media such as molecular sieves (or, for iodine, reacted to form the stable compound silver iodide [AgI]), or they may be removed and contained with the metal wastes (carbon-14) and salt wastes (iodine-129) above.

Although the indicated matrix materials have been cited in recent studies,[4,6,7,8] the optimal form for each pyroprocessing waste has not been determined.

B.4.2 <u>Calculated Volumes</u>

This section outlines the steps taken to calculate the volume of waste resulting from pyroprocessing sufficient light-water reactor spent nuclear fuel to supply the initial loading and two reloads for the 19 advanced liquid-metal reactors assumed in the case, through 2030. Note that the number of waste packages will vary with the following parameters:

- Burnup level of the light-water reactor spent nuclear fuel to be reprocessed: a typical value of 33,000 megawatt-days per metric ton is used in much of the technical literature, but some studies indicate that higher burnup rates may be more likely in the future[9].

- Actinide-recovery rates for pyroprocessing: rates that range from 99.9 percent to 99.999 percent are given by the technical literature.

- Matrix or waste form in which gaseous fission products are contained for disposal.

- Sizes and types of packages used to contain the wastes produced by the pyroprocessing.

The first step in this calculation is to determine the amount of light-water reactor spent fuel that will be reprocessed by 2030 under the case. Given an assumed reactor design (Section 5.2) and the fact that a metric ton of light-water reactor spent nuclear fuel contains about 9.72 kilograms of transuranics,[8] each advanced liquid-metal reactor will require reprocessing of between 1,480 and 2,449 metric tons of light-water reactor spent nuclear fuel for an initial loading and two reloads, and between 47.3 and 48.4 metric tons per year thereafter.[10,11] The ranges in these data reflect differences in current advanced liquid-metal reactor designs, which have not yet been fully optimized for actinide burning. Other values pertaining to the fuel requirements of advanced liquid-metal reactors stated in the published literature fall within these ranges.

Assuming that one new reactor per year begins operation from 2012 to 2030 (Section 5.2), advanced liquid-metal reactors will accumulate a total of 171 reactor-years by 2030. To supply the start-up fuel for 19 new reactors and make-up fuel for 171 reactor-years, between 36,200 and 54,800 metric tons of light-water reactor spent nuclear fuel will need to undergo pyroprocessing by 2030.

The second step in this calculation is to determine the volumes of high-level radioactive waste resulting from the pyroprocessing of this 36,200 to 54,800 metric tons of light-water reactor spent nuclear fuel. Here, these volumes were calculated by scaling data from two studies[6,7] to obtain the expected volumes of high-level radioactive wastes from each 1,000 metric tons of light-water reactor spent nuclear fuel reprocessed. Table B-1 lists the resulting number of containers and the total quantity of waste generated by 2030. As noted in Section B.3, however, the suitability of all such packages for repository disposal of wastes has not been thoroughly evaluated.

B.5 WASTES GENERATED FROM PYROPROCESSING OF ADVANCED LIQUID-METAL REACTOR SPENT NUCLEAR FUEL

B.5.1 Description

The pyroprocessing of spent nuclear fuel from advanced liquid-metal reactors results in four principal waste streams:[3,4,12]

- Fuel hardware consisting of stainless steel cladding hulls that contain activation products, such as carbon-14 and radioactive isotopes of nickel, and residual actinides.

- Electrorefining metal that contains rare earth and noble metal fission products, zirconium, uranium, cadmium, and small amounts of transuranic elements together with process wastes, such as anode baskets, fume traps, and crucibles.

- Electrorefining salt that contains halide (bromine and iodine), alkali-metal (rubidium and cesium), alkaline earth (strontium and barium), and major portions of the rare earth (yttrium, samarium, and europium) fission products along with small amounts of the actinide elements.

- Noble gases, primarily the fission products krypton-85 and xenon-131.

Matrix materials for these wastes are similar to those described above for wastes from the pyroprocessing of light-water reactor spent nuclear fuel: electrorefining metal would be contained in a copper metal matrix (either alone or in combination with the fuel hardware), and the electrorefining salt would be contained in a compressed zeolite form.

B.5.2 Calculated Volumes

The partitioning and transmutation case assumes that all spent nuclear fuel from advanced liquid-metal reactors is pyroprocessed, resulting in the production of new fuel, uranium metal, and high-level radioactive waste (Section 5.3.3). This section describes how the volumes of waste resulting from pyroprocessing advanced liquid-metal reactor spent fuel were calculated.

The number of high-level radioactive waste packages that will result from pyroprocessing the spent fuel from each advanced liquid-metal reactor depends on several factors:

- The rate of fuel throughput for the reactor, which in turn depends on the design and operational parameters of the reactor.

- The actinide recovery rate for the pyrochemical process: rates ranging from 99.9 to 99.999 percent are cited in the published literature.

- The matrix or waste form in which each waste stream is contained for disposal, and the extent to which waste streams are combined in common matrices. Although the indicated matrix materials have been cited in recent studies,[3,10,12,13] the optimal form for each pyroprocessing waste has not been determined.

- The size, type, and thermal output of the waste packages.

Based on assumed capacity factors of 0.7 to 0.8, each advanced liquid-metal reactor of the reference design will generate between 977 and 1,116 megawatt (electric)-years of power during each year of operation. By 2030, the 19 reactors deployed in this case will have operated a total of 171 years, producing between 167 and 191 gigawatt (electric)-years of power. The quantities of high-level radioactive waste from pyroprocessing have been derived from the results of three recent studies.[7,8,12] By scaling these data to the values given above for expected power production by 2030, the total quantities of high-level radioactive waste from pyroprocessing were calculated. Table B-2 lists these quantities in terms of the number of waste packages per 100 gigawatt (electric)-years of power production.

According to the results of one study,[14] the number of waste packages from pyroprocessing advanced liquid-metal reactor spent nuclear fuel may be reduced by up to 32 percent by altering the waste package dimensions to increase the heat output of each package up to limits that may be acceptable for waste emplacement in a repository. The number of waste packages shown in Table B-2 are calculated based upon common the range of package dimensions used in the studies cited. As noted in Section B.3, the suitability of all such packages for repository disposal of wastes has not been thoroughly evaluated.

B.6 REDUCTION IN GENERATION OF LIGHT WATER REACTOR SPENT NUCLEAR FUEL

The partitioning and transmutation case will reduce the generation of spent nuclear fuel from light-water reactors (Section 5.3.4). This section describes how that reduction was calculated.

As described in the preceding section, the partitioning and transmutation case would result in the net generation of between 167 and 191 gigawatt (electric)-years of power by 2030. If this power were generated by light-water reactors rather than by advanced liquid-metal reactors, then the light-water reactors would produce 28 metric tons of spent nuclear fuel per 1,000 megawatt (electric)-years,[8] or a total of between 4,700 and 5,300 metric tons of spent nuclear fuel through 2030. The partitioning and transmutation case eliminates the production of this quantity of light-water spent nuclear fuel.

B.7 SUMMARY OF EFFECTS ON SPENT NUCLEAR FUEL INVENTORY

Compared with the upper reference case, the partitioning and transmutation case will reduce spent nuclear fuel inventories through the reprocessing of spent nuclear fuel from light-water reactors to produce new fuel for advanced liquid-metal reactors, and less power generation by light-water reactors than in the upper reference case. These reductions in spent nuclear fuel inventories are tabulated and applied as changes to the upper reference case in Table B-3. The net result is a total of 55,700 to 74,900 metric tons of spent fuel produced in the partitioning and transmutation case. However, as shown in Tables B-1 and B-2, the partitioning and transmutation case would also produce more high-level waste than the upper reference case.

Table B-3

Spent Nuclear Fuel Produced Through 2030 in the Partitioning and Transmutation Case

Type of Waste	Light-Water Reactor Spent Nuclear Fuel Inventory Metric Tons of Heavy Metal
Light-water reactor spent nuclear fuel reprocessed to produce new advanced liquid-metal reactor fuel (removed from the spent nuclear fuel inventory)	(-)36,200 to (-)54,800
Light-water reactor spent nuclear fuel needed to produce power equal to that produced by advanced liquid-metal reactors (prevented from entering the spent nuclear fuel inventory)	(-)4,700 to (-)5,300
Subtotal	(-)40,900[a] to (-)60,100
Spent nuclear fuel produced in the upper reference case (Sec. 3)	(+)115,800
Total spent nuclear fuel produced by the partitioning and transmutation case (and assumed in the advanced liquid-metal reactor scenario)	(+)55,700 to (+)74,900

(a) Subtracted from the amount of spent nuclear fuel produced in the upper reference case (i.e., 115,800 metric tons of spent nuclear fuel) to obtain amount produced in the partitioning and transmutation case.

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APPENDIX C

RESPONSES TO COMMENTS ON DRAFT REPORT

APPENDIX C

RESPONSES TO COMMENTS ON DRAFT REPORT

The Department of Energy has made copies of this report available to the public, regulatory agencies and interested parties for review and comment. Comments were received from 17 groups or individuals. Some comments came as letters; some as statements at public hearings.

Comments were analyzed and divided into 15 major topics. Those topics are the sections of this appendix, which is the vehicle through which the Department of Energy is formally responding to comments. Each topic includes these elements:

- A summary of comments received on each topic.
- A response from the Department of Energy, including specific reference to changes made in the report or the reason why the suggested changes were not made.
- Each individual comment pertaining to that topic. These comments are paraphrased and cross-referenced to the comment letter from which it came.

Following the summaries is a full copy of the comments.

C.1 SCOPE OF REPORT

Summary of Comments

Many commentors called for actions, conclusions or recommendations that went beyond the scope of the report, as defined in the Energy Policy Act. One commentor said the report did not go far enough, and that low-level wastes should be examined. Another commentor said the report went too far, and that high-level waste should not be included. Several commentors suggested that the report should make recommendations, or that a commission should be created to study program changes. One wanted the current waste-management program stopped until an independent review could be completed, and several backed the recommendation for an independent review.

One commentor had numerous suggestions, including that the report does not say who is culpable for nuclear-related adverse effects, and that the report does not specifically guarantee that a repository will be safe. Also, this commentor suggested that the report examine alternative disposal methods.

Response

Section 803 of the Energy Policy Act directs the Secretary of Energy to "prepare and submit to the Congress a report on whether current programs and plans for management of nuclear waste as mandated by the Nuclear Waste Policy Act of 1982 (42 U.S.C. 10101 et seq.) are adequate for management of any additional volumes or categories of nuclear waste that might be generated by any new nuclear power plants." The Department believes this report satisfies that directive.

The report was revised to add to the Introduction an explanation of what the Department believed Congress was asking for in this report and how the Department met that intent. Waste other than commercial spent nuclear fuel is included in the report when it is the responsibility of the Department as mandated by the Nuclear Waste Policy Act. Low-level radioactive waste is not included because it is not covered by the Nuclear Waste Policy Act.

An independent commission was not established because Congress directed the Secretary of Energy to conduct the review. The Secretary assigned the task to the Office of Civilian Radioactive Waste Management, the Departmental office most knowledgeable of current programs and plans for management of nuclear waste as mandated by the Nuclear Waste Policy Act of 1982.

The report makes no recommendations for future actions, such as cessation of production of more waste, because they were not requested by Congress in Section 803 of the Energy Policy Act of 1992.

Individual Comments

The content of the report exceeds the assessment of current waste management plans called for in Section 803 of the Energy Policy Act. (Edison Electric Institute)

The DOE went beyond the scope of Section 803 of the Energy Policy Act by considering waste types unrelated to commercial spent nuclear fuel and by studying the effects of partitioning and transmutation. The analysis in these areas should immediately be discontinued. (American Nuclear Energy Council)

An external, independent Commission - rather than the DOE - should be appointed to review all current radioactive waste policies and programs. The Department should endorse this concept as a means of addressing the requirements of Section 803. (Committee to Bridge the Gap, et al.)

All radioactive waste programs must be reevaluated together in order to develop a rational waste classification system which provides for appropriate and consistent treatment of long-lived radioactive wastes. (Committee to Bridge the Gap, et al.)

The report does not reflect the massive increases in "low-level" waste which would result from expansion of the front end of the nuclear fuel cycle (particularly the reprocessing of irradiated fuel). (Committee to Bridge the Gap, et al.)

The first step in successful management of the wastes already generated is cessation of production of more waste, and this action DOE should take immediately and should recommend to the Congress. (Environmental Coalition on Nuclear Power)

We urge the Secretary to recommend that the President create a truly independent commission (with a preponderance of ordinary affected citizens and experts selected from and by the environmental community) to review and recommend changes in the entire program for the management of all forms of radioactive waste. (Environmental Coalition on Nuclear Power)

The Energy Department should halt the existing waste programs for which it bears responsibility, pending the completion of a full independent review and the Congressional or Administrative actions necessary to improve the control of all radioactive wastes. (Environmental Coalition on Nuclear Power)

Governor Andrus earlier commented on the annotated outline, that the report goes beyond the Congressional mandate and could bias actions to manage the nation's nuclear waste. This concern remains. (Idaho)

The report's introduction should state up front what the Energy Department thinks Congress asked for and whether and how the Department has met that intent in the report. (Las Vegas Meeting Notes)

The Energy Policy Act of 1992 primarily serves special interests rather than the public. The public is virtually excluded from the Act, yet will be adversely affected by it. (McGowan, Tom)

Although the hazards of nuclear radiation are well-known and implicitly acknowledged in the Energy Policy Act, the Section 803 Report does not admit the culpability of any government or private entity for any nuclear-related adverse impacts. (McGowan, Tom)

It is impossible and irresponsible to attempt to sever the Section 803 Report from the entire history of nuclear energy and policy to date. (McGowan, Tom)

The Section 803 Report does not address the specific means of guaranteeing the safe isolation of nuclear wastes in a repository. (McGowan, Tom)

The Section 803 Report makes no mention of alternative means of nuclear waste disposal, including: (1) sub-surface waste disposal in the deep Arctic Ocean, and (2) permanent storage of nuclear waste in ground-tethered, atmospherically suspended secure repositories. (McGowan, Tom)

Efforts are needed to achieve a broad-based (national and global) public consensus concerning the rational and responsible application of nuclear power and the disposition of nuclear wastes. (McGowan, Tom)

C.2 EFFECTIVENESS OF CURRENT PROGRAMS AND PLANS

Summary of Comments

Many commentors said the report was unrealistically optimistic in both its assessment of current programs and its prediction for future successes. Commentors cited three reasons that an accurate examination could not take place: the lack of an updated Mission Plan Amendment; the outdated Site Characterization Plan for Yucca Mountain; and incomplete regulatory standards. Commentors also mentioned unresolved program issues, such as interim storage and transportation.

Commentors suggested that the Department of Energy is underestimating the technical, social and political factors that may prove to be obstacles as current waste-management programs progress and decisions are made in the future.

Response

The report has been changed to include in section 1, Introduction, a clearer explanation of the scope of this evaluation. The Department recognizes that formidable challenges exist in managing waste from existing nuclear power plants. However, the focus of this evaluation is on managing waste from future nuclear power plants. The Department does not view this evaluation as the means for resolving the challenges that currently exist. The proper vehicle for addressing the existing challenges is the Secretary's review of the program and section 1 was revised to include a discussion of the elements of that review.

Individual Comments

Given the highly critical remarks of the NWTRB, the report should present conclusions and recommendations about the adequacy of the Energy Department's institutional, organizational, and management abilities that will be needed to carry out the plans and programs for managing current and future waste inventories. Furthermore, the uncertainties that plague the Department's existing depository program and the diffused and uncoordinated management decisions keep the program in a permanent state of transition. (Nevada - letter)

The facts presented in the report do not support its conclusions. The Department has not yet demonstrated that its waste management program is in compliance with key requirements of the Nuclear Waste Policy Amendments Act (NWPAA), as it has not published a comprehensive Mission Plan. Without a Mission Plan, a credible Site Characterization Plan, and without regulatory standards to guide site characterization, the Department cannot determine the adequacy of existing programs. (Nevada - letter)

Plans now in place cannot handle the current, known spent nuclear fuel inventory much less projected increases in SNF inventories and other waste destined for disposal. This report should identify the limitations associated with current plans and the recommendations being developed by the Department. The report should be revised to accurately reflect the state of nuclear waste management in this nation. (Idaho)

The report's analysis provides only perfunctory commentary on a number of unresolved issues, i.e., interim storage, transportation, etc. The report needs to better reflect the complexities of these issues as the true implication that these problems are not addressed. (Clark County, Nevada)

There have been a number of recommendations calling for a independent review of the program. Since a number of issues are beyond the responsibility of the Energy Department, e.g., non-proliferation, this report should be prepared by an independent research organization that would provide a fresh approach to the topic. (Clark County, Nevada)

The introduction is very scanty. The nuclear waste issue is tremendously complex and the introduction should provide more detail on some of the background of issues involved in the current program. including transportation, monitored retrievable storage versus on site storage at the reactor, statutory limitations on the repository and some concrete idea of the volume amounts for the Reference Case. (Esmeralda County, Nevada)

The conclusion that the "current waste management programs and plans are adequate..." is based upon flawed assumptions and is an unrealistic view of the effectiveness of current plans. (Idaho)

The General Accounting Office (GAO) and the NWTRB called for a complete and independent review of the current program and plans. The report needs to justify its rationale that the current programs and plans are adequate, or at least acknowledge that there are problems which could adversely affect the results of the analysis. (Clark County, Nevada)

The report does not address inadequacies of management plans for nuclear waste from currently authorized sources. (Sierra Club, Virginia Chapter)

This draft report clearly is not adequately responsive to the intent of the Congressional directive in the 1982 Energy Policy Act. A fundamental factor that seems to have been ignored by the Energy Department is the increasing level of difficulty in storing, managing, and permanently sequestering radioactive wastes from the biosystem as total quantity of wastes generated continues to increase. (Environmental Coalition on Nuclear Power)

Since the NWPAA was passed, the Mission Plan has not been amended to describe current programs. (Environmental Coalition on Nuclear Power)

Adding to the inventory of long-lived radioactive waste is irresponsible and should stop. Building and operating more reactors will only compound the existing radioactive waste crisis. (Committee to Bridge the Gap, et al.)

The report fails to realistically evaluate current plans and programs for managing nuclear waste since DOE denies that real technical, political, and cultural challenges remain unmet. In reality, there is no proven safe site, transport, or method of permanent radioactive waste disposal. (Committee to Bridge the Gap, et al.)

There is no clear definition of the scope of the Secretary's planned evaluation of existing programs or its relationship to the statute, this report, or the future generation of radioactive waste. (Committee to Bridge the Gap, et al.)

It is an unstated assumption of the report that all OCRWM programs will proceed perfectly with no social, political or technical barriers, no unforeseen events and exactly as DOE intends. This highly unlikely assumption should be altered to reflect more realistic scenarios. (Committee to Bridge the Gap, et al.)

Unfounded assumptions are made that the current waste crisis will be resolved by 2030 and that new plans will be vastly more expedient than has been realized to date. These assumptions are not likely given the lack of progress in solving the spent-fuel disposal problem to date. (Committee to Bridge the Gap, et al.)

The report states that "the Department has considerable experience with repository siting..." In light of the Secretary's program review, this statement is not true. (Nevada - statement)

C.3 CONCLUSIONS

Summary of Comments

There was a clear dichotomy of opinion in reactions to the report's conclusions. Some commentors said conclusions were correct, and the program is flexible enough to respond to changing needs. More commentors, however, said the Energy Department has inefficient management and schedule slippages that will affect program decisions, particularly relative to deciding whether a second repository is needed. One commentor said the Department has created a "circular argument" by saying on one hand that there now is time to make course changes in the program, but, on the other hand, that those changes will be completed by the time a decision must be made about a second repository. The commentor said this argument does not answer the question raised for the report, which is whether current plans and programs are adequate.

Response

The report has been changed to include in Section 8, Conclusions, a better definition of "current programs and plans," along with the assumptions on which the report's conclusions are based. The report was revised in Section 6.2.1 to address the possibility of a schedule slip in the repository program and what ramifications that slip might have. Also, we have changed the report in Section 6.2.1 to better describe events that will take place leading up to a decision about a second repository.

One commentor said the Department did not consider waste emplacement capacities, facility designs or facility cost estimates in reaching the conclusion that waste management is at an early stage and there is opportunity to adjust for changes in needs. We maintain that specific discussions of capacities, designs and costs are not needed to answer Congress's question, but we explain better what plans are in place and how they can be modified as required.

Two additional suggested changes were made:

- We will identify license renewal plans and decisions, as discussed in section 6.3.2, as decisions to be made by utility companies.
- We will acknowledge that changes in programs and plans will be required.

Individual Comments

The lack of a solution to the nuclear waste problem to date is presented as a strength, and used to justify more waste generation. In fact, there is **no solution**, and the generation of additional waste should stop. (Committee to Bridge the Gap, et al.)

The report argues that current programs are adequate because there is time to make them adequate. The question raised by Congress is not whether DOE has enough time to develop programs to address future waste-management needs but, whether current programs are now adequate to address such future needs. The DOE 's response reassures Congress that all is well with its programs even if a considerable increase in the volumes of waste occurs. This reassurance belies both past and present experience with nuclear waste programs which shows a futility of thinking that "there is sufficient time" to deal with this problem. (Inyo County, California)

With the program's management/financial problems, it is likely that the decision for the first repository will not have been made by before the decision for the second repository is required in the time-frame 2007-2010. The report should acknowledge that the picture is highly optimistic and may not be realistic. (Clark County, Nevada)

The report does not reflect that the GAO reported that the current time line for the repository is slipping to 2020. (Esmeralda County, Nevada)

The report states that there is sufficient time to modify programs and plans for new plant waste since it will not occur until 2020 or 2030. The report also states that development of waste-management systems is at an early stage "allowing ample opportunity to accommodate changing needs" as "major facilities for storage, transportation, and disposal have not been sited, and final designs for their construction have not been developed." But by 2020 or 2030 when the additional waste volumes are known, design and construction of the first repository, and ancillary transportation and storage requirements will have long since been committed. The DOE seems to be saying that the programs and plans have flexibility now and do not need to plan for waste increases that will not occur until the flexibility no longer exists. This circular argument needs to be re-examined. (Inyo County, California)

By General Accounting Office estimates site characterization may not be completed until 2006 to 2013 and therefore it cannot be assumed that it will be completed in time to support the evaluation of a second repository. It is also optimistic to assume an overlap of waste emplacement and waste generation when second repository construction is expected to be completed in 2040 but new reactor operation will not be terminated in 2050. (Inyo County, California)

The DOE did not consider waste-emplacement capacities, facility designs or facility cost estimates in reaching the conclusion that waste management is at an early stage, allowing ample opportunity to adjust for changes in needs. (Idaho)

ANEC concurs with the report's conclusion that, because there is sufficient lead time to adequately assess future disposal capacity, the current waste-management system is adequate to handle additional spent fuel from advanced reactors built after the enactment of the Energy Policy Act of 1992 and, consequently, there is no need at this time to institute a second repository program. (American Nuclear Energy Council)

EEI/UWASTE agrees with the Department's conclusion that "current waste-management programs and plans are adequate for any additional volumes and categories of nuclear waste produced by new nuclear plants." (Edison Electric Institute)

The license renewal plans and the decisions concerning such plans as discussed in section 6.3.2 are, more specifically, "utility" plans and decisions and should be so identified. (Nuclear Regulatory Commission)

The report is incorrect in its conclusion that current waste-management programs and plans are adequate for any additional volumes and categories of nuclear waste produced by new power plants. To the contrary, there is every reason to believe that the current inadequacy of Energy Department management plans for dealing with spent nuclear fuel and high-level waste would be even worse if additional nuclear power plants were to be constructed and licensed. (Sierra Club, Virginia Chapter)

DOE should acknowledge that changes will be required. (Washington, DC Meeting Notes)

C.4 REPOSITORY CAPACITY

Summary of Comments

Commentors said they believe the report is short-sighted and is taking a risky approach by not defining the projected capacity of Yucca Mountain. One commentor said the DOE was being brazen in presenting to Congress a scenario that presumed Congress would amend the Nuclear Waste Policy Act to accommodate a higher amount of waste at the candidate repository. Other commentors said the report, through its scenarios, clearly shows that waste will exceed the 70,000 metric ton limit set on Yucca Mountain. Therefore, an assessment should be made about what to do with expected waste generation beyond that level.

One commentor agreed with the conclusion and said many unknown factors will play into the need for a second repository, and that a decision now would be premature.

Response

The Nuclear Waste Policy Act limits the emplacement of more than 70,000 metric ton of waste in a first repository until a second repository is emplacing waste and requires the Department to report on the need for a second repository between 2007 and 2010. In this evaluation the Department does not presume that Congress should change either of these requirements.

The Department believes that, as 2007 approaches, it will be better prepared to make a reasoned decision on the need for a second repository. Projections in the report show that, over time, there will be more than 70,000 metric tons of waste for disposal. This means that, even if we would consider the current estimated capacity of Yucca Mountain inadequate, there is an adequate plan to address future needs. Congress has left open the options for how to deal with additional amounts of waste, and we believe the date set for making a decision about the second repository is appropriate.

The report has been changed in section 6.2.1 to make it clear that all three scenarios exceed 70,000 metric tons but the focus of the evaluation is on the timing of determining the need for a second repository. Additional detail was added to section 6.2.1 to explain the relationship between thermal loading and repository capacity and the Department's plans for establishing a thermal loading strategy.

Individual Comments

The Reference Scenario excluding some sources, assumes that 100,000 metric tons of waste will be generated. The waste from the sources not included will exceed the 100,000 metric tons by 20 percent. Given this information the current plans for disposal cannot be said to be adequate. The current basis for waste management at Yucca Mountain is the SCP which was developed on the assumption that the waste volumes would not exceed the statutory limit. Thus the SCP is driving the design of a repository that is intended to accommodate at least 80 percent less waste than will be produced under the Reference Scenario let alone the Upper-Bound or ALMR Scenarios. (Inyo County, California)

By not estimating repository capacity the DOE will miss the intent of Section 803 of the Energy Policy Act. Clearly, the requirements suggest that the Congress wants to know the available capacity of the Yucca Mountain Site or a generic repository. Such an estimate is critical for determining the adequacy of existing plans and programs to handle future waste generation. (Nevada - letter)

The amount of SNF anticipated under the Upper Reference Case and the Reference Scenario each exceed the 70,000 metric ton limit of the repository and all the Scenarios do not take into account the greater-then class C waste and the waste from weapons dismantlement, destined for geologic disposal. (Idaho)

By developing different Scenarios, the report establishes that the Reference Case exceeds 100,000 metric tons, which is already well above the statutory limit for Yucca Mountain. Despite this the report concludes the decision regarding a second repository need not be reached until 2007. The Energy Policy Act is the prevailing legislation on the second repository and not the NWPAA. The Energy Policy Act requires examination of the need for additional repositories. The report suggests that the first repository could hold increased volumes of waste since the limitations are statutory rather than technical. It is premature to assume that the law would be changed. (Esmeralda County, Nevada)

In other reports (presumably written by Office of Civilian Radioactive Waste Management (OCRWM) task forces) the capacity limitation of the repository has been challenged and suggestions made to remove the requirement. (Idaho)

The report states that the capacity may exceed 70,000 metric tons, but does not discuss that this would take an act of Congress which would have to reopen the NWPAA accompanied by considerable debate and deliberation. (Clark County, Nevada)

Some Nevadans perceive this report as a first attempt by DOE to change the NWPAA again to make Yucca Mountain the sole repository regardless of the volume of waste to be disposed. The report should not assume that Yucca Mountain can absorb all existing waste and the waste from new reactors. Nor should it assume that the law would be changed to permit this. Postponing that decision on a need for a repository until 2007 is poor planning. Contingencies need to be developed and backup sites may have to be determined. (Esmeralda County, Nevada)

The report seems to indicate that the current program plan is to determine: (1) the volume of waste; (2) the capacity of Yucca Mountain; and then (3) change the law to fit the disposal requirement. To base a plan on the assumption of flexibility in Congressional directives is risky. There is a certain audacity in reporting to Congress that current plans are adequate because of an assumption that Congress will change the law to fit the plan. (Inyo County, California)

ANEC agrees with the conclusion that "increased quantities of nuclear waste does not mean that additional repositories will be needed." In reaching this conclusion, the Report recognizes that the need for a second repository program is dependent upon many factors that cannot be settled today, including the number of new plants built, the amount of waste generated by each of these plants and the capacity of the first repository. (American Nuclear Energy Council)

The amount of high-level waste that will go to a first repository is statutorily capped at 70,000 metric tons heavy metal. To imply that the final capacity may be increased by the site characterization process is to ignore the law. (Committee to Bridge the Gap, et al.)

The report failed to estimate the waste emplacement capacity of Yucca Mountain and therefore, DOE cannot assume that additional repositories will not be needed in the near term. (Nevada - letter)

C.5 SCENARIOS

Summary of Comments

Reviewers found the scenarios confusing, unrealistic and inadequate. They said the scenarios did not reflect adequately the ultimate volume of high-level waste that might be produced for disposal. Also, one commentor said the figures are confusing because defense wastes and miscellaneous wastes are neither quantified nor well-defined.

Response

Section 2.1 was revised to emphasize that both the upper reference scenario and advanced liquid-metal reactor scenario do not represent the Department's expectations or wishes. Instead, the scenarios provide upper bounds on the amount of future waste to be managed by the Department. The scenarios are meant to be "what if" analyses and are, by design, high estimates. We included the liquid-metal reactor scenario and other high estimates to ensure that we consider any eventuality currently known.

Section 7 was extensively revised to more clearly describe miscellaneous waste that are not included in the scenarios. Specific quantities of miscellaneous waste types were added where known. The amounts of miscellaneous waste were compared to the amounts of waste in the scenarios to demonstrate more clearly that they represent a small amount relative to the waste included in the scenarios.

The Department adopts four comments in the report:

- We estimate, in section 3.3, that four or five new reactors per year would be required between 2010 and 2030 to fulfill the upper reference case projection of 181.2 net gigawatts (electric).

- We revised Figures 3.1 and 3.2 to indicate that waste production for the upper reference case will extend beyond 2030.

- We estimate, in section 7, the amount of spent fuel that would be generated by 2030 as a result of the Department ending reprocessing.

- We revised section 3.3 to define which provisions of the Energy Policy Act would contribute to the resurgence of the nuclear power industry.

In response to the specific comment regarding Nuclear Waste Fund fees, current nuclear power production results in about $550 million being collected annually from the 1 mill per kilowatt-hour fee. Since production in 2030 under the upper bound scenario would be about twice current production, the fee collected would double to about $1.1 billion per year. This can be estimated by multiplying the annual capacity of all reactors (reported in gigawatts) by 8,760 hours per year and multiplied again by a capacity factor of 0.70 for existing reactors or 0.75 for new reactors. This result would be multiplied by 0.94 to account for transmission loss and on-site electricity use and multiplied again by 1,000,000 to convert from gigawatt-hours to kilowatt-hours. The resultant kilowatt-hours would be multiplied by $0.001 per kilowatt-hour to arrive at an annual collection in dollars.

Individual Comments

The Upper-Bound and ALMR Scenarios are unrealistic in view of current economic, regulatory and political constraints on new reactor development, and recent decision of Congress to cut back ALMR research. (Inyo County, California)

The report leaves many unanswered questions about the total inventory as the figures are confusing about the miscellaneous waste not included in the Scenarios and the amount of defense wastes is undetermined. (Esmeralda County, Nevada)

The three Scenarios in the report do not take into account the "Other Wastes" and fail to include reliable estimates of high-level waste (HLW) generated from Department of Energy (DOE) defense reprocessing activities. By excluding "Other Wastes" from the three Scenarios, the report fails to fully assess the adequacy of existing plans and programs for the management of wastes generated at current or future projected levels. The ultimate volume of HLW that might be produced for disposal is not adequately discussed in the draft report. (Nevada - letter)

The Upper-Bound and Advanced Liquid-Metal Reactor (ALMR) Scenarios are not realistic in light of the adverse public opinion of new nuclear power plants and if the Energy Efficiency Standards of the Energy Efficiency Act are effective, then the Reference Case would become the upper limits of waste generation. (Clark County, Nevada)

Table 6-1 and Figure 6-1 are misleading. The total waste packages are shown in the ALMR Scenario but are not shown for the Reference and Upper-Bound Scenarios. This indicates a relatively higher number of packages for the ALMR Scenario than for the other Scenarios, a conclusion which is not correct. The number of waste packages for disposing of SNF should be included for consistency of comparisons. (GE Nuclear Energy)

An estimate should be given as to the number of light-water reactors that might be built to fulfill the projections of the new-orders scenarios. (Committee to Bridge the Gap, et al.)

The graphs and tables in the Draft Report which compare the three scenarios are misleading in that: (1) they do not indicate that waste production for the new-orders cases will continue far beyond 2030; and (2) there is no opportunity to view the scenarios without the assumption of increased burnup rate. (Committee to Bridge the Gap, et al.)

The report does not discuss at all the practicality of the three scenarios - specifically, the projected costs and environmental and human health impacts of the scenarios are ignored. (Committee to Bridge the Gap, et al.)

Develop a projected analysis of the ultimate amount of spent fuel that would be generated since DOE has ended reprocessing. (Nevada - statement)

Section 3.3 of the report sounds like a promotion of new nuclear power plants. What are the "many" provisions of the 1992 Energy Policy Act referred to? (Las Vegas Meeting Notes)

The report should include a table to compare units of electrical power cited in the report against the units (Kwh) which form the basis of Nuclear Waste Fund fees charged to utilities. (Las Vegas Meeting Notes)

C.6 REGULATORY COMPLIANCE

Summary of Comments

Commentors said the report ignored regulatory compliance and suggested that the DOE should actively lobby for the rules and regulations it feels it needs to do a credible job in waste management.

Response

Under the Nuclear Waste Policy Act, the Environmental Protection Agency (EPA) is responsible for establishing generally applicable standards for protection of the general environment from offsite releases from radioactive material in repositories; the Nuclear Regulatory Commission (NRC) is to establish requirements and criteria that are not inconsistent with the EPA standards and specify how these standards must be complied with by the DOE.

As explained in section A.1.1, the EPA promulgated 40 CFR 191 in 1985 and the U.S. Court of Appeal for the First Circuit vacated Subpart B of 40 CFR 191 in 1987. DOE has taken the position on the 1985 standard that (a) it was unnecessarily conservative and reflected a numerical risk that was unusually low in comparison with other risks commonly considered acceptable to society; (b) the hybrid technical achievability-health risk basis for the standard was unacceptably stringent; and (c) the unprecedented long-term and probabilistic nature of the standards enhance the predictive uncertainties in demonstrating compliance.

In light of the position taken by DOE and others such as NRC and its Advisory Committee on Nuclear Waste (ACNW), Congress passed the Energy Policy Act on October 24, 1992, which provides for the National Academy of Sciences (NAS) to develop recommendations for the EPA to follow in establishing health-based standards, a move that will make the U.S. standards consistent with the practice in many other countries, as well as with the recommendations of the International Commission on Radiation Protection (ICRP).

In response to a comment, we have clarified that statements made in section 6.2.6, "Regulatory Framework of the Waste-Management Program," are attributable to the Department and its interpretations.

Individual Comments

The report ignores issues pertaining to regulatory compliance. The report should acknowledge that it is likely that new dose rates and new release standards will emerge from revisions to existing regulatory strategies contained in Title 40 Code of Federal Regulations, Part 191, and that when regulatory problems have been encountered in the past, DOE has lobbied Congress to rescind the obstacle concerning regulatory compliance. (Nevada - letter)

Rather than hope (or lobby) for any relaxation of regulatory standards or requirements, DOE should of its own volition radically increase its own rules for the period of isolation, standards for future exposures, and design requirements for spent fuel and HLW. (Environmental Coalition on Nuclear Power)

Statements in section 6.2.6 of the report should be expressly attributed to DOE. (Nuclear Regulatory Commission)

C.7 HIGH-LEVEL RADIOACTIVE WASTE VOLUMES

Summary of Comments

Commentors criticized the report's speculation about the volume of high-level waste that will be produced. One said the report should address the volume issue and its potential effect on how much waste can be deposited in the first repository.

Response

The report has been changed in several places in Section 4 to explain better the relationship between treatment methods and the number of canisters produced. More information was provided to update the current status at the Savannah River Site and the Hanford Site.

Individual Comments

The report fails to discuss the reason for the large disparity in the number of HLW canisters that will be produced. (Nevada - letter)

At a minimum the report should address the HLW volume issue and its potential impact on the amount of waste that can be disposed in the first repository. (Nevada -letter)

The figures for the canisters at Hanford are confusing and speculative. According to a presentation made to the NWTRB in may 1992 the number of canisters shipped to the repository could exceed 200,000. (Esmeralda County, Nevada)

The report should make note of the stalled vitrification project at Hanford and that currently 'a "re-baselining study" to determine alternatives for management, treatment and disposal of the Hanford waste is being conducted. (Nevada - letter)

The report does not quantify the high-level waste production from the advanced liquid-metal reactor scenario. Undefined units of "packages" and "canisters" are used with no mass or volume units attached. (Committee to Bridge the Gap, et al.)

The 1993 date shown for the start of HLW vitrification on page 12 of Mr. Shelor's presentation should be revised. (Las Vegas Meeting Notes)

C.8 CONTINGENCY PLANS

Summary of Comments

Commentors found fault with the report's lack of statement of contingency plans. One commentor said the report should include a plan for program redirection if the Yucca Mountain site is found to be not suitable for the first repository.

Response

Contingency planning for an array of program eventualities, including Yucca Mountain unsuitability as a radioactive waste repository, is conducted on a regular basis. The Office of Civilian Radioactive Waste Management invites participation by small groups of key interested and informed external parties in workshops to consider alternatives to current program directions. In the case of the Secretary's determination that Yucca Mountain is unsuitable, the principal contingency remains the requirement of the Nuclear Waste Policy Act ,as amended, to terminate site characterization activities and to notify the Congress, the Governor and the legislature of Nevada of such termination (see expanded discussion in section A.1.6). An investigation of domestic and foreign siting experiences is underway and the results of this study will inform further contingency planning activities.

Individual Comments

There are no backup sites nor any program contingencies under contemplation. Thus, should there be a need to abandon the Yucca Mountain Site the system cannot "be adjusted to meet requirements." (Nevada - letter)

The report should discuss contingency options if, for example, the Yucca Mountain site should be found to be unsuitable, or if a redirection is called for in the program. (Clark County, Nevada)

There is no mention of contingency plans should Yucca Mountain prove unsuitable. (Esmeralda County, Nevada)

C.9 MONITORED RETRIEVABLE STORAGE

Summary of Comments

The report bases its assumptions on the idea that, when an interim storage facility is needed, one will be available. Some commentors said that base is optimistic, from both political and technical views, and that the report should include a more thorough examination of interim storage. A commentor suggested that all scenarios include interim dry-cask storage at reactor sites, which this commentor said would result in finding current plans and programs are inadequate because the DOE will not have fulfilled its legal obligation to accept spent nuclear fuel in 1998. Another commentor suggested that the DOE should abandon attempts to find an MRS site until the questions about the first repository are answered.

Response

The report has been revised in several places to update the discussions of the current status of storage options, including 1998 waste acceptance, the development of multi-purpose canisters and ongoing negotiations to find a volunteer site for a monitored retrievable storage facility. The evaluation has taken a more realistic view of the prospects of siting a monitored retrievable storage facility and has factored in the developing multi-purpose canister strategy.

The scenario analysis in section 6.2.2 has been clarified to note that interim storage refers to either at-reactor storage or storage at a monitored retrievable storage facility or at a Federal site.

Section 6.2.2 continues to note that, regardless of the method used for interim storage of spent fuel prior to placement into a repository, the capability exists within the industry, and within the Federal government, to provide adequate and safe storage of spent nuclear fuel.

Section A.1.3 has been revised to update the status of monitored retrievable storage facility site negotiations and to reiterate that the Department continues to support the voluntary siting process. Section A.2.2 has been revised to add information regarding the multi-purpose canister strategy. Section A.2.3 has been revised to explain how the multi-purpose storage canister strategy fits into the waste-management system schedule estimate.

In response to a specific comment, the report was modified in section A.1.1 to include a precise description for "short-term" storage facilities.

Individual Comments

The statutes require DOE to begin accepting waste for disposal by January 1998. This deadline has not been changed and thus should be discussed in the report, as the decision for a repository site will not be finalized until 1998 and it is highly unlikely that the Monitored Retrievable Storage (MRS) will be available at that time. Rather than basing the program assumptions on the existence of a MRS by 1998, the report should base all the Scenarios, and in particular the Reference Case, on the assumption that interim dry cask storage will be used for spent nuclear fuel (SNF) at existing reactor sites. And then the DOE must conclude that its current plans and programs are inadequate to handle existing waste under the stipulated time periods. Along this same line, and because of the uncertainty of the total volume of all wastes, the report should also assess the requirement to advise Congress on the need for a second repository. (Nevada - letter)

The report assumes that the interim storage issue can be looked at later. The search for a MRS site has been ongoing since 1983, with DOE announcing that a site was chosen in Tennessee in 1985, however, there is still no interim storage site ten years after the search began. The report is too optimistic in assuming that the siting problem could be readily resolved. The report needs to address interim storage more thoroughly. (Esmeralda County, Nevada)

It is unlikely that a MRS will be in place by 1998 nor a repository by 2010. (Inyo County, California)

To assume that the "final storage concept could be selected, designed, and licensed, and the facility built within 5 to 10 years of selecting the site" is unwarranted optimism. Given the continuing difficulties of siting a MRS facility and growing resistance to long term storage the "need for additional storage capacity prior to final disposal" that is requested by Congress in Section 803 of the Energy Policy Act should be considered in more detail. (Inyo County, California)

The Monitored Retrievable Storage (MRS) program should not proceed without being able to guarantee a repository. An MRS may not even be a necessary component in a waste management system. (Committee to Bridge the Gap, et al.)

A more precise description for the "short-term" storage facilities mentioned in the 1st bullet on page A-3 of the draft report is "storage in an independent spent fuel storage installation or a monitored retrievable storage installation." (Nuclear Regulatory Commission)

The constraints on storage and disposal that are set out on page A-7 apply to any monitored retrievable storage facility authorized pursuant to Title I of NWPA, as amended, Section 142(b), 42 USC 10162. They do not necessarily apply to a facility established pursuant to a negotiated agreement that is enacted into federal law pursuant to Title IV of NWPA, as amended. (Nuclear Regulatory Commission)

C.10 ENVIRONMENTAL ANALYSIS

Summary of Comments

Two commentors said the report lacks environmental analysis, and that there should be a review of risks associated with the production of additional nuclear fuel, transportation and storage, as well as additional power plants.

Response

Section 1 was revised to explain that the subject of this report is the evaluation, on a programmatic level, of the adequacy of DOE waste management plans and programs to manage additional waste which may be generated by nuclear power plants constructed and licensed after October 24, 1992. For the purposes of this report, it is assumed that implementation of these programs and plans will proceed in accordance with design, performance, qualitative and quantitative testing and analysis (including environmental, safety, and health), and operations criteria, as well as provisions for state, local, and public interaction as required by applicable laws and regulations. There is an extensive array of environmental analyses required to gain approval to implement these plans including, but not limited to, environmental assessments and environmental impact statements required by both the Nuclear Waste Policy Act and the National Environmental Policy Act as well as site characterization studies and safety analysis reports required by the Nuclear Regulatory Commission. The applicability and adequacy of these environmental analyses will be validated through required federal, state, local, and public interaction processes prior to implementation of waste-management operations. General statutory and regulatory requirements upon which these determinations would be based in the future are incorporated by reference in Appendix A and throughout the body of the report.

Individual Comments

The report is devoid of environmental analysis. The report does not analyze the additional environmental risk associated with the production of additional nuclear fuel, additional onsite risks, additional transportation risks, nor the additional long-term risks of nuclear waste storage pertaining to the licensing of additional nuclear power plants. (Sierra Club, Virginia Chapter)

Realistic environmental analysis appears to be woefully absent from the report. (Environmental Coalition on Nuclear Power)

C.11 PARTITIONING AND TRANSMUTATION

Summary of Comments

Most commentors opposed raising the idea of partitioning and transmutation as an option in the waste-management cycle. Commentors said that the technology is untested and currently is expensive. One said taxpayers should not pay for this technological development.

One commentor said the actinide recycling system should be in the report and could be potentially important to long-term waste management.

Response

Section 5 has been revised to more clearly explain that this report does not recommend for or against partitioning and transmutation as a waste-management tool. The length of the section in the draft report led some to conclude that the Department was advocating this technology within the context of this report. This is not the case. Partitioning and transmutation continue to be included in the evaluation because they are being considered as waste-management options and have the potential to significantly affect waste management if implemented. The technical details explaining how waste quantities were derived have been moved to Appendix B.

Individual Comments

Transmutation is not a feasible alternative. (Clark County, Nevada)

The section of the report on partitioning and transmutation (P-T) should be completely eliminated. The costs of these technologies are not addressed nor the difficulties inherent in commingling canisters containing SNF with canisters containing corrosive salts. (Nevada - letter)

The entire P-T section appears to be an advertisement for new technology. It is unlikely the P-T will become part of the waste management strategy. Additionally there could be criticality issues involved with P-T and that the wastes may not be appropriate for geologic disposal. (Esmeralda County, Nevada)

The ALMR Actinide Recycle System should continue to be in the context of this report because of its potential importance to long-term waste management. (GE Nuclear Energy)

Advanced liquid-metal reactors are dangerous, untested, and will add to rather than alleviate the nuclear waste problem. These reactors will greatly add to the costs of geologic disposal while providing dubious benefits, and should not be built. (Committee to Bridge the Gap, et al.)

Advanced liquid-metal reactors (discussed in Chapter 5 of the report) are expensive, unneeded, and not economically viable for either power generation or radioactive waste disposal. Federal (i.e., taxpayer) funds should not be used to develop this technology. (National Taxpayers Union)

Section 5 of the report should address the potential for increased criticality problems in the disposal of new waste types resulting from ALMRs. (Las Vegas Meeting Notes)

C.12 TRANSPORTATION

Summary of Comments

Commentors said transportation is an "unknown" in the current waste-management plans and programs. One said the report should address transportation routes, as well as containers and methods of transportation. Another believes massive transportation will not be tolerated by the public. And another said the DOE should remain aware that the Nuclear Regulatory Commission will have a major say in transportation certification and notification of routes.

Response

The report was changed in Section 6.2.3 to explain that an increase in the amount and types of waste and the location of these wastes will have an impact on the OCRWM transportation system. However, the activities needed to address these impacts are ongoing, and there will be ample time to adjust the transportation system to accommodate additional wastes.

The shipments of spent fuel and high-level waste will constitute a small fraction of the hazardous waste shipments on the nations highways and railroads. However, the Department of Energy is aware of the public concern over such shipments and has implemented several programs in conjunction with various stakeholder groups to minimize these concerns. In addition, current planning is to move as much of the waste as possible by rail, thereby reducing the effect on the motoring public.

The Office of Civilian Radioactive Waste Management has consistently stated that it would comply with all applicable federal, state, tribal, and local laws and regulations in the transportation of spent fuel and high-waste. For example, prior to being required to do so by the Nuclear Waste Policy Act, the Office of Civilian Radioactive Waste Management agreed to have its transport casks certified by the Nuclear Regulatory Commission.

Individual Comments

The report avoids transportation issues and states that there will be ample opportunity later to develop casks. Increased waste generation indicates the need for more cask development and greater volumes of waste will add to the shipments. The increased impacts on transportation may require revisiting the choice of modes for transport, and the need for and the location of the MRS facility. The report needs to address the effects on transportation routes, shipping containers, and modes of transport. (Esmeralda County, Nevada)

It is not clear that any program relying on the massive transport of high-level waste on the nation's highways will be tolerated by the affected localities. (Committee to Bridge the Gap, et al.)

There are several references in the draft report to NRC regulations with respect to transportation of wastes (pages 6-10 and A-3). It is clear that DOE must use NRC-certified packages for transportation and that DOE must abide by NRC regulations regarding advance notification of State and local governments (Nuclear Waste Policy Act of 1992 (NWPA), as amended, Sec. 180, 42 USC 10175). (Nuclear Regulatory Commission)

C.13 EPA AND NRC PARTICIPATION

Summary of Comments

One commentor said the report appears to be lacking the EPA and NRC comments prescribed in the law.

Response

The Nuclear Regulatory Commission and the Environmental Protection Agency have been active participants in the development of this report. Both agencies participated in an initial scoping meeting where an annotated outline of the report was discussed. Both agencies offered their comments and views which were carefully considered when developing the draft report. Both agencies were provided copies of the draft report and participated in a meeting where they expressed there comments and views of the draft report. These were carefully considered when developing the final report. In addition, both agencies were provided advance copies of the final report and invited to document their final views on the report. The Nuclear Regulatory Commission's views are provided in Appendix D, and the Environmental Protection Agency's views are provided in Appendix E.

Individual Comments

It is not clear what contribution EPA or NRC made to the preparation of the Draft Report. DOE does not appear to have fulfilled the requirement for multi-agency consultation in preparing this report. (Committee to Bridge the Gap, et al.)

C.14 SUITABILITY OF YUCCA MOUNTAIN

Summary of Comments

One commentor said the report assumes that Yucca Mountain will be operating as a mined disposal facility within 20 years. This commentor, citing schedule slippages, said the Yucca Mountain site will never be found suitable for waste disposal.

Response

This assumption is not made in the report. However, Section A.1.6 was revised to explain that two preliminary assessments regarding the suitability of Yucca Mountain have already been made: an environmental assessment in 1986 and an early site suitability evaluation in 1992. Further, the Nuclear Waste Technical Review Board asserts that no site disqualifiers have been identified to date.

Individual Comments

Throughout the report it is an unstated assumption that Yucca Mountain will in fact be an operating mined disposal facility within the next 20 years. This is incorrect since the Yucca Mountain Project is seriously behind schedule, and the Yucca Mountain site is unsuitable to hold any waste at all. (Committee to Bridge the Gap, et al.)

C.15 MISCELLANEOUS WASTE

Summary of Comments

Commentors believe high-level wastes associated with government-owned materials should be part of the evaluation of current plans and programs.

Response

The report has been changed in Section 7 to reflect the individual comments made about this section.

Individual Comments

The NRC staff recommends that DOE consider high-level wastes associated with the disposition of government owned materials to be inventoried as stated in Section 1016 of the Energy Policy Act of 1992. Without including these additional wastes in its evaluation of the waste disposal system, DOE may not be completely analyzing all the waste that will require final disposal in a deep geologic repository. (Nuclear Regulatory Commission)

The waste in the miscellaneous section is listed as metric tons except the overseas input of 6,000 to 12,000 assemblies. These assemblies should be converted to metric tons. (Washington, DC Meeting Notes)

A conclusion is needed at the end of Section 7. (Washington, DC Meeting Notes)

COMMENTS RECEIVED ON THE DRAFT REPORT

American Nuclear Energy Council

Clark County, Nevada

Committee to Bridge the Gap, et. al.

Edison Electric Institute

Environmental Coalition on Nuclear Power

Esmeralda County, Nevada

GE Nuclear Energy

Idaho

Inyo County, California

McGowan, Tom

National Taxpayers Union

Nevada (letter)

Nevada (statement)

Nuclear Regulatory Commission

Nye County, Nevada

Sierra Club, Virginia Chapter

AMERICAN NUCLEAR ENERGY COUNCIL

Edward M. Davis
President

August 20, 1993

Mr. Dwight E. Shelor
Office of Civilian Radioactive
  Waste Management
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Subject: Comments of the American Nuclear Energy Council on the Department of Energy report entitled Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-level Radioactive Waste

Dear Mr. Shelor:

The American Nuclear Energy Council (ANEC) is pleased to respond to the Department of Energy's (DOE) request for comments concerning the report entitled Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-level Radioactive Waste (Report). ANEC represents over 100 companies with an interest in nuclear energy, including investor, public, and cooperatively-owned nuclear utilities, manufacturers, architect-engineers, nuclear waste management, and other firms engaged in the nuclear fuel cycle.

ANEC concurs with the Report's conclusion that, because there is sufficient lead time to adequately assess future disposal capacity, the present waste management system is adequate to handle additional spent fuel from advanced reactors built after the enactment of the Energy Policy Act of 1992 (EPACT) and, consequently, there is no need at this time to institute a second repository program. However, ANEC also believes DOE went beyond the scope of Section 803 by considering waste types unrelated to commercial spent nuclear fuel and by studying the effects of partitioning and transmutation, as detailed in the comments of the Edison Electric Institute's Utility Nuclear Waste and Transportation Program submitted to DOE on April 6, 1993, and on August 15, 1993, and that using Nuclear Waste Fund monies to perform analysis of these areas is beyond the scope of Section 803 and should immediately be discontinued.

To properly assess DOE's conclusions, it must be determined if the Report satisfies the intent of Congress under Section 803. That intent is clear and unambiguous in the statutory language:

> "the Secretary of Energy... shall prepare and submit to the Congress a Report on whether current programs and plans for management of nuclear waste as mandated by the Nuclear Waste Policy Act of 1982... are adequate for management of **any additional volumes or categories of nuclear waste that might be generated by any new nuclear energy power plants that might be constructed and licensed after**" October 24, 1992 (emphasis added).

From this language, the statute directs DOE to analyze only whether the current programs and plans are adequate to manage additional spent fuel volumes generated by new advanced reactors constructed after 1992. Based on this strict limitation in DOE's authority under EPACT, ANEC concurs in DOE's conclusion that the present programs and plans are adequate, as detailed below.

First, ANEC agrees with the conclusion that "increased quantities of nuclear waste does not mean that additional repositories will be needed." In reaching this conclusion, the Report recognizes that the need for a second repository program is dependent upon many factors that cannot be settled today, including the number of new plants built, the amount of waste generated by each of these plants and the capacity of the first repository.

The capacity of the repository is one the most speculative of the factors affecting this program. DOE recognizes this by stating that "only when site characterization has provided enough data will it be possible to determine the first repository's disposal capacity, and only from that can we determine the need for a second repository." This is because the on-going studies of Yucca Mountain have yet to determine if the site is suitable, much less what the potential capacity of that repository might be. Moreover, scientists have yet to determine what thermal loading configuration the repository will be able to sustain, thereby making any assumptions on capacity purely speculation.

Additionally, ANEC also concurs with DOE's finding that the "development of the waste management system is at an early stage, allowing ample opportunity to accommodate changing needs." There is no need **today** to make a speculative conclusion about a second repository program, because this is **not** the last time DOE will consider this issue.

As the Report notes, the current evaluation pursuant to EPACT is not intended to replace Section 161 of the Nuclear Waste Policy Act of 1982, as amended (NWPA), which mandates DOE to conduct a study between 2007 and 2010 as to "the need for a second repository." In light of this, ANEC believes that DOE is correct in concluding that the Section 161 study will better address the speculative factors that cannot be adequately determined today and that "any need for increased storage or disposal capacity can be handled by the current program planning process."

Finally, the Report indicates that some projections of the potential generation of spent fuel are beyond the 77,000 metric ton NWPA limits on the first repository. However, the Report found most of the potential increase in projected spent fuel volumes "would occur between 2020 and 2030, leaving ample time to make program adjustments," and to gain confidence in these speculative projections. The industry concurs with DOE's approach to wait until the Section 161 report is concluded, in order to assess the uncertainty in waste volume projections.

Sincerely,

Edward M. Davis

Clark County

Department of Comprehensive Planning
Nuclear Waste Division
CALIFORNIA FEDERAL BUILDING
301 EAST CLARK AVENUE, SUITE 570
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(702) 455-5175

August 20, 1993

U.S. Department of Energy (DOE)
Dwight Shelor, Associate Director
Systems and Compliance
Office of Civilian Radioactive
Waste Management (OCRWM)
Washington, D.C. 20585

CLARK COUNTY, NEVADA'S COMMENTS ON THE DEPARTMENT OF ENERGY SECTION 803 REPORT

Dear Mr. Shelor:

Attached are comments from the Clark County (Nevada), Department of Comprehensive Planning, Nuclear Waste Division to the "Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-level Radioactive Waste," released for comment by the Department of Energy (DOE).

These comments were provided at the July 20, 1993, DOE meeting in Las Vegas. As I noted at the meeting, the Division wants this statement to be included as formal response to the report. Likewise, we would like a written response to the concerns and issues raised in our testimony.

If there are questions or comments please contact the Division at (702) 455-5175. Thank you for your assistance.

Sincerely,

Dennis A. Bechtel
Coordinator

DB/al
attachments
CC: James Ley
Richard B. Holmes

L730

COMMENTS ON

"ADEQUACY OF MANAGEMENT PLANS FOR THE FUTURE GENERATION OF SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE"

SECTION 803 OF THE ENERGY POLICY ACT OF 1992

CLARK COUNTY, NEVADA
DEPARTMENT OF COMPREHENSIVE PLANNING
NUCLEAR WASTE DIVISION

DENNIS A. BECHTEL, COORDINATOR

JULY 20, 1993

Clark County, Nevada
Department of Comprehensive Planning,
Nuclear Waste Division

Comments on "Adequacy of Management Plans for the Future Generation of Spent Fuel and High-Level Radioactive Waste"

Section 803 of the Energy Policy Act of 1992 requires the Department of Energy (DOE) to submit a report to the President and Congress on **"whether current programs and plans for management of nuclear waste as mandated by *The Nuclear Waste Policy Act, as amended,* are adequate for the management of any additional volumes or categories of nuclear waste that might be constructed and licensed after the date of enactment of the act."** In performing this task DOE is required to consult with The Nuclear Regulatory Commission (NRC), The Environmental Protection Agency (EPA) and other interested parties, the affected counties and other interested parties.

As background, Clark County was named by DOE as an affected unit of government in 1988 under provisions of the NWPA, as amended. Under these auspices we offer the following comments to Section 803 of the Energy Policy Act of 1992.

1) The document notes that **"the Department has concluded that current waste management programs and plans are adequate for any additional volumes and categories of nuclear waste produced by new power plants..."** We have some difficulty in understanding the basis for these conclusions.

The General Accounting Office (GAO), the President's Nuclear Waste Technical Review Board (NWTRB), among others have concluded that because of schedule slippages, program cost escalation, the limited amount of funds that have actually been expended on site characterization analysis, that a complete and independent review of DOE's civilian waste program needs to be performed. A number of highly credible organizations have questioned the adequacy of DOE's plans and procedures.

In order to provide a better foundation for discussing the managment requirements of future amounts of spent fuel and high-level radioactive waste, the report needs to justify the rationale for its conclusions that the current programs and plans are adequate. Short of this, however, the report needs to acknowledge that there are problems, which could adversely affect the results this analysis.

2) The selection of the scenarios in the report is difficult to understand. The "Reference" scenario offers perhaps the greatest credibility, although there may be some uncertainty as to the volumes being generated. It does acknowledge, however, the present reality that a nuclear power plant has not been licensed in the United States for well over twenty years.

2) [Continued]

Both the "Upper Bound" and "Advanced Liquid-Metal Reactor" scenarios posit that nuclear power will continue to be a significant producer of electricity in the U.S. Unless there is a dramatic shift in opinion by the American public, however, it seems unlikely that nuclear power will reclaim the support it once enjoyed prior to Three Mile Island. The scenarios which consider the construction of additional nuclear facilities, especially in the numbers presented, therefore, do not appear to be viable. Perhaps the statement in Section 6.3.3 about the Energy Efficiency Standards in the Energy Policy Act (Page 6-11), which in essence could reduce energy demands may mean that the "Reference" scenario defines the upper limits of waste generation.

Also , unless the U.S. totally discards the "non-proliferation" concept, is it unlikely that "transmutation," despite its purported attraction (still not totally proven, however) of reducing the waste volume and the length of time period of the extreme toxicity of radioactive waste, will be a feasible alternative.

3) A number of statements in the document (ES-2; first paragraph, and Page 6-8, second paragraph for example) note that the proposed first repository may have capacity that exceeds the mandated NWPA total of 70,000 Metric Tons. Not discussed, however, is the fact that the NWPA would require Congressional action to revise the 70,000 Metric Ton amount stipulated in the law. While Congress obviously has the capability to remove the 70,000 ton cap, its removal will still require a reopening of the NWPA, accompanied by considerable debate and deliberation. This should be discussed.

4) Given the management/financial problems that a number of organizations have noted with DOE's program, it is conceivable that a decision on a first repository may not have been made by the time when DOE is required to evaluate the need for a second one (the years 2007-2010). The report should acknowledge, therefore, that the highly optimistic picture presented may not be realistic. The report should discuss contingency options if, for example, the Yucca Mountain site should be found to be unsuitable, or if a redirection is called for in the program.

5) The report totally avoids the second repository issue by noting that the decision to evaluate the need for one is not necessary 2007-2010. With the history of attempting to site a first repository fresh in our minds, it is important that the second be approached in a different manner. It should be evident that it will be extremely difficult to site a facility of this type anywhere. If there is any potential for success, the U.S. can perhaps draw on the experience gained in other countries where, in most cases, the approachs have concentrated on voluntary siting.

6) The analysis provides, unfortunately, only perfunctory commentary on a number of issues associated with the current DOE program (or potential needs) which are presently unresolved. This could have significant implications on questions with respect to future waste.

"Interim Storage," for example, will probably be as complex as siting a repository. Five or ten years may not in fact be sufficient time for an interim storage site, given the probable need for the development of an environmental impact statement, etc. As another example the question of the "Transportation" of the waste is an issue of national scope and could also be a difficult variable in future waste generation scenarios.

The report needs to better reflect the complexity of all these issues. Short of a more rigorous analysis, the true implications of the problems that will be faced are not truly presented.

7) There have been a number of recommendations calling for the independent review of DOE's program. It is probable that a report such as this should be prepared by an organization able to provide a "fresh" view to the topic at hand. Since a number of the issues are probably beyond the responsibility of DOE (e.g. non-proliferation), it is probable that this report should be produced by a research organization.

Clark County appreciates the opportunity to speak to the issues discussed in the Section 803 report. We look forward to the response to our concerns. If you have additional questions please contact me at 455-5175.

Committee to Bridge the Gap, Greenpeace, Native Americans for a Clean Environment, Nuclear Free America, Nuclear Information and Resource Service, Physicians For Social Responsibility, Public Citizen's Critical Mass Energy Project, Sierra Club Energy Committee, U.S. Public Interest Research Group

Comments On The June 1993 Draft Report:

"Adequacy Of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste A Report to the President and the Congress In Accordance with Section 803 of the Energy Policy Act of 1992"
Submitted August 20, 1993

The opportunity for public comment on this Draft Report is set forth in Section 803 of the National Energy Policy Act of 1992 (the Act). We appreciate that the framers of Section 803 provided us with this opportunity. These comments are offered on behalf of the members of the organizations signed below.

Section 803 of the Act directs the Secretary of Energy in consultation with the Nuclear Regulatory Commission (NRC) and the Environmental Protection Agency (EPA) to "submit ... a report on whether current programs and plans for the management of nuclear waste as mandated by the Nuclear Waste Policy Act of 1982 (42 USC 10101 et seq.) are adequate for the management of any additional volumes or categories of nuclear waste that might be generated by any new nuclear power plants that might be constructed and licensed after the date of the enactment of this Act."

To date, there is neither the technology nor the regulatory structure to ensure complete isolation for the full hazardous life of the radioactive materials and wastes already generated by human activity. Adding to the inventory of long-lived radioactive waste is irresponsible and should stop.

Viewed within the context of the geologic time scale of the hazardous life of radioactive wastes from nuclear reactors, the electricity produced by these plants is highly ephemeral. In functional terms, the primary product of a nuclear reactor is radioactivity--released out the stack and the discharge pipes, contaminating components, surfaces, air, water, land, food, exposing workers and the public, and accumulating as waste--both irradiated fuel and so-called "low-level" radioactive waste from operations. Increasing and accelerating the accumulation of human-made ionizing radioactivity by operating <u>more</u> reactors will only compound the existing radioactive waste crisis.

The Draft Report Does Not Fulfill The Requirements of The Act

Section 803 of the Act requires an evaluation by the Department of Energy (DOE) in consultation with NRC and EPA of the current radioactive waste programs. The Draft Report fails to realistically evaluate current programs and plans for the management of nuclear waste--the clear directive of Section 803. Instead, DOE sidesteps and attempts to reframe the statutory assignment, offering an evaluation of its own "program planning process"[1] in relation to three hypothetical scenarios of future waste generation.

In a public comment session on July 29, 1993, the authors stated that evaluation of the existing programs is being conducted in another arena by Energy Secretary O'Leary. There is no clear definition of the scope of the Secretary's evaluation or its relationship to the statute, this Report, or the future generation of radioactive waste.

It is not clear what contribution EPA or NRC made to the preparation of the Draft Report. NRC would license any future nuclear power plants and waste facilities; EPA has statutory oversight and sets standards for disposal. In our view it is highly appropriate that section 803 of the Act states that the assessment and report on future waste generation be developed with multi-agency consultation. It is not clear that DOE has fulfilled this requirement of the Act.

We question whether DOE is capable of making an honest, critical evaluation of its waste management abilities. The "Sustainable Energy Blueprint" prepared by a broad coalition of public interest organizations for the Clinton Administration's transition calls for a White House Commission on Radioactive Waste to coordinate a 3 year comprehensive, independent evaluation of current U.S. radioactive waste programs and policies. This review would reassess the entire spectrum of radioactive waste including "low-level," high-level, military, commercial, mixed, and transuranic waste management programs. (See attached section of the Blueprint.)

In order for a meaningful assessment of radioactive waste management, the critical question of waste classification itself needs to be addressed. Today materials like Plutonium-239 and Iodine-129 with hazardous lives of hundreds of thousands of years are allowed, inappropriately, in primitive shallow land burial dumps with an institutional control period of only 100 years. These same radionuclides are the justification for federal regulations demanding assurance of integrity for at least 10,000 years in the high-level radioactive waste program.

The need for a rational waste classification system which reflects the hazardous life of the materials as well as toxicity and other factors is the fundamental reason that all radioactive waste programs must be reevaluated together. Such reassessment could impact the volumes and characteristics of the high-level radioactive waste stream and the requirements for long-term containment.

We believe that the Department should endorse this concept of an external review in the Final Report as a means of addressing the requirements of Section 803.

Unstated, Unrealistic Assumptions of the Draft Report

It is an unstated assumption of the Report that all of the programs of the Office of Civilian Radioactive Waste Management (OCRWM) including: current waste production, acceptance,

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[1] Federal Register Notice " Preparation of Nuclear Waste Management Report , (page 33803)." 58 FR 117:33802--33804. Monday, June 21, 1993.

transport, MRS, handling, repository characterization, siting, construction and disposal will proceed perfectly with no social, political or technical barriers, no unforeseen events and exactly as DOE intends. This highly unlikely assumption should be altered to reflect more probable scenarios but in any case, the assumptions should be stated clearly in both the Introductory and Summary sections of the Report as well as any other sections giving the operating assumptions.

The fact is that the vast majority of the irradiated fuel is still in fuel pools on reactor sites. All of the current OCRWM programs are still on the drawing boards. All face significant barriers for implementation and are flawed in numerous respects. We are 50 years into the nuclear age and well over half-way through the first nuclear era (the 'no new orders case') and the waste is sitting exactly where it was made. The Report does not explain how, given these circumstances, the situation is going to change.

Throughout the report it is an unstated assumption that Yucca Mountain is not only being studied for a possible repository site, but that it will in fact be an operating mined disposal facility within the next 20 years. This cannot and should not be assumed. According to the U.S. General Accounting Office, the Yucca Mountain Project is already 5--13 years behind the projected 2010 commissioning date. Moreover there is no determination of suitability for the site."[2] An independent analysis has pointed out that each time a projection is made for the opening of the facility, it recedes farther and farther into the future.[3]

An assumption which is presented, but is inappropriate, is that the underground site characterization of Yucca Mountain will determine the disposal capacity of that proposed repository. The amount of high-level waste that will go to a first repository is statutorily capped at 70,000 metric tons heavy metal. To imply that the final capacity may be increased by the site characterization process is to ignore the law.

We question that Yucca Mountain is appropriate to hold any waste at all. The site has already shown to be technically flawed, geologically, hydrologically, and physically.[4] A variety of experts have stated that the mountain will not retain the radioactive gases that will be released in the course of the decay of the waste.[5] It is not clear today why the Department has not followed the script intoned in Appendix-A of the Report: "If at any time the Yucca Mountain Candidate

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2 U.S. General Accounting Office, "Yucca Mountain Project Behind Schedule and Facing Major Scientific Uncertainties," Washington D.C.: U.S. GAO May 1993.

3 Makhijani, Arjun, and Scott Saleska, "High-Level Dollars, Low-Level Sense, A Critique of Present Policy for the Management of Long-Lived Radioactive Waste and Discussion of an Alternative Approach." Institute for Energy and Environmental Research, Takoma Park, MD. 1992.

4 Syzmanski, J.S. 1989. Conceptual Considerations of the Yucca Mountain Groundwater Systems with Special Emphasis on the Adequacy of this System to Accommodate a High-Level Nuclear Waste Repository. DOE Internal Report, U.S. Department of Energy, LasVegas, NV. and State of Nevada Comments on the U.S. Department of Energy Site Characterization Plan, Yucca Mountain Site, Nevada, Vol. 1--4. September 1989.

5 Dr. U-Sun Park; Weeks, Thorstenson, Trautz, LeCain and others; cited by David K. Kreamer in "Report of Peer Review Panel of the Early Site Suitability Evaluation of the Potential Repository Site at Yucca Mountain, Nevada." Yucca Mountain Site Characterization Project, Office of Civilian Radioactive Waste Management, U.S. DOE, January 1992.

Site is found to be unsuitable for a geologic repository, then all work on the site will cease."[6] Work on this flawed project should have stopped already.

Instead, the Yucca Mountain project was given exemption (in a different section of the Act), from the EPA radiation protection standards for high-level waste disposal. In 1991 experts[7] openly stated that the proposed facility would not be able to meet the EPA regulations. Rather than assess whether this might disqualify the site--not meeting regulations is often the criteria for such a judgment when it is made empirically--a political route was taken to disqualify the EPA standard instead. This irresponsible action of the Energy Policy Act erodes the credibility that radioactive waste management in this country is based on sound science. This is an extremely dangerous precedent in the consideration of policy regarding future accelerated generation of radioactive waste.

The determination to proceed with the MRS program in the face of a questionable ability to guarantee a repository is shaky at best, and contradicts provisions of the Nuclear Waste Policy Act. A growing number of analysts are stating the position that an MRS is not a necessary component in a waste management system.[8]

Communities are rejecting the transportation of fuel that was barely irradiated at Shoreham. It is not clear that any program relying on the massive transport of high-level waste on the nation's highways will be tolerated by the affected localities.

DOE's Conclusions: "No Solution" is a Solution

The Report's review of the Department's 'program planning,' concludes that because it will take half of the 40 year study period (through 2030) for new reactors to go on line, there will be time to plan how to deal with additional waste generated. A major assumption is being made that the current waste crisis will be resolved in that same interval, as well as an unfounded assumption that new plans will be vastly more expedient than has been realized to date.

That we are 50 years into the nuclear age with no "solution" to the waste problem is reported as a strength with respect to planning for additional waste generation. DOE argues that there is flexibility and time to modify the existing plans, and therefore they conclude that these plans do not need to be changed. This is like saying that people that have been homeless for most of their life have flexibility about where they live.

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6 Draft Report: "Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste" A Report to the President and the Congress in Accordance with Section 803 of the Energy Policy Act of 1992, U.S. DOE , June 1993. Page A-7.

7 Discussion at the 29th Meeting of the NRC's Advisory Committee on Nuclear Waste, March 21, 1991, Dade Moeller presiding.

8 "Nuclear Waste: Is There a Need for Interim Storage?" Report of the Monitored Retrievable Storage Commission, November 1, 1989; and "Operation of Monitored Retrievable Storage Facility is Unlikely by 1998" GAO/RCED-91-194.

There is no confidence that any of the Department's waste management plans will succeed in providing isolation and containment for the hazardous life of the waste. Our conclusion that there is **no solution** is quite different than DOE's convoluted logic that having not solved these problems justifies more waste generation. The rational, logical conclusion is to bound the equation and stop the generation of additional waste.

One Third of the Report Devoted to Dangerous, Untested, Waste Generating, So-Called Waste Reduction Scenario

Three scenarios are presented for the years 1992--2030: No-new orders case, which assumes no license extension of existing reactors. Upper reference case which assumes 70 % of existing reactors will extend the operating license for 20 years and an unspecified number of additional light water reactors will be built, to come on-line starting in 2006. The third scenario is the same as the second, with the addition of one advanced liquid metal breeder reactor (ALMR or breeder) coming on-line each year, starting in 2012, for a total of 19 within the study period.

Because the calculations were not made to tell us how many light-water reactors may be built it is difficult to fully describe the new-orders scenarios. Variability in reactor design capacity and assumptions about significantly increased burn-up of fuel make it impossible to extrapolate this figure from the parameters given for increased generating capacity. Given the degree of variability and uncertainty in other parameters covered by the Report, it is odd that the number of light water reactors that might be built to fulfill the scenario projections is not at least estimated. In contrast, the report is quite detailed in looking at the addition of 19 breeder reactors to the program. Experts on the ALMR program have referred to a ratio of one breeder reactor to four light water reactors. With this equation , the new-order scenarios may represent 76 new light water reactors on-line in the study period.

The graphs and tables in the Draft Report which compare the three scenarios are misleading. They do not indicate that waste production for the upper reference case and the breeder case continues far beyond 2030, the end of the study period. In fact, only 15 years of new waste generation is contained in the projections, yet in this time the upper reference case shows a cumulative total of 34% more irradiated fuel by the end of the study period than the no-new orders case. It should be noted that the assumptions about increased burn-up rate lower the projection for the amount of irradiated fuel generated within the study period by the upper reference and breeder scenarios. We are not given the opportunity to view the scenarios without the assumptions of an increased burn-up rate of about 20 % above industry average rate of 1991.

The Report gives no treatment what so ever of practicality considerations in these scenarios. Even costs are dismissed as something that can be assessed as the scenario progresses. The Report makes no attempt at a cost projection and therefore provides no measure of the advisability of these scenarios in even the most rough economic terms. Moreover, the Report does not consider environmental and human health impacts. Without consideration of costs, it is also not possible to use this report to make a comparison to other possible scenarios, for instance, non-nuclear alternatives for energy production.

Scenarios involving new reactor construction, continuation and expansion of the front-end of the nuclear fuel cycle, and particularly the resumption of reprocessing of irradiated fuel, would result in massive increases in the category currently classified as "low-level" waste. This impact is not reflected in the report. Reprocessing will also transfer material from the irradiated fuel category in to the high-level waste category. The Report does not quantify the high-level waste production. Instead undefined units of 'packages' and 'canisters' with no mass or volume units attached are given. Traditional reprocessing techniques have resulted in massive increases in volume of wastes.

The authors stated on July 29th, 1993 in a public comment session that the Report is not intended to promote any particular technology. However, one third of the scenario consideration is devoted to the construction of 19 new advanced liquid metal reactors deployed allegedly for consumption of irradiated fuel from light water reactors. In responding to a request for more citations of peer reviewed research that substantiates the claim of <u>any</u> overall benefit in waste reduction or relief of the need for very long term waste isolation, the authors admitted that perhaps analysis of the ALMR technology should occupy an appendix in the report rather than one third of the scenario text.

We offer the appended testimony and references given by Ms. Anna Aurilio for USPIRG before the Senate Energy Committee on August 5,1993 as further comment on the subject of ALMR technology and so-called actinide recycling. Broad scale deployment of a putative waste reduction program which, in fact, produces more waste would be to fall prey to a dangerous form of false advertising.

Claims for the reduction of the hazardous life of long-lived radionuclides by this technology are not only unproven and technically questionable, but do not address those long-lived radionuclides most likely to leak from a long-term isolation unit because of their volatility and solubility, these include: Carbon-14, Iodine-129, Selenium-79, Technicium-99 and Cesium-135. None of these radionuclides would be "burned up" by an ALMR breeder, but instead would be continuously generated by both the ALMRs and the light water reactors "feeding" the breeders. In addition, many activated metals in irradiated reactor components will be radioactive and hazardous for many millennia and should be isolated. Building more reactors would inevitably increase this long-lived waste stream, which also cannot be "burned up."

It should be noted here that the whole concept of pyroprocessing is completely untested at an industrial scale. It has been suggested that this treatment of high-level waste could be accomplished at the ALMR sites. This technology requires the one thing which to date has been avoided at all costs: the melting of irradiated fuel rods. Routinely melting fuel at multiple sites will not make it safe or low-risk. It is unlikely that such a program would increase public trust or confidence in reliance on nuclear power.

In order to portray the 'next generation' of waste in a positive light, DOE has to side-step practical considerations and massage the variables. The study period looks at only the start-up decade-and- a-half of waste generation, assumes a much higher rate of burn-up of fuel, and does not quantify additional high-level wastes from reprocessing. Further, a third of the Report's projections are based on an unsubstantiated promise of waste reduction from an untested technology that will actually expand the waste problem. All of the scenarios are framed by the assumption of an already functioning, but as yet, non-existent waste isolation program.

In considering the wastes from a 'next generation' of reactors, it is not inappropriate to remember that the current generation of nuclear power has not come close to fulfilling many of the promises made--in construction costs, generating capacity, maintenance costs, safety, health impacts and cost of energy delivered, especially when we face the real costs and hazards of stewarding billions of curies of long-lived radioactive poisons. The Report continues a 50-year tradition by the nuclear power industry and federal agencies of optimistic but unfulfilled assumptions. In reality, there remains no proven safe site, safe transport, or method of safe, permanent storage of radioactive waste. In our view, prevention is the only real cure to the waste problem.

In issuing a Report that does not fulfill the charge given by Section 803 of the National Energy Policy act of 1992, DOE continues to deny that real, technical, political and cultural challenges remain unmet. We call for an external, independent Commission to conduct a full review of **all** current radioactive waste policies and programs including, but not limited to the Office of Civilian Radioactive Waste Management.

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TESTIMONY OF ANNA AURILIO
STAFF SCIENTIST
U.S. PUBLIC INTEREST RESEARCH GROUP
before the
COMMITTEE ON ENERGY AND NATURAL RESOURCES
U.S. SENATE

August 5, 1993

Good morning, Mr. Chairman and members of the committee. I am Anna Aurilio, Staff Scientist for the U.S. Public Interest Research Group. I am pleased to be invited to present our concerns about the environmental implications of the Advanced Liquid Metal Reactor (ALMR) and Actinide Recycle Program.

U.S. PIRG is the national lobbying office of the state Public Interest Research Groups. PIRGs are non-profit, non-partisan and work on environmental, consumer and good government issues in more than 30 states.

In 1983, with the termination of the Clinch River Breeder Reactor program, Congress emphatically rejected the concept of breeder reactors on the grounds that this technology is uneconomical and has little commercial application, while posing serious environmental, safety and proliferation risks. The price of uranium has fallen since those times, making breeders even less economically attractive than ten years ago, and commercial breeder reactors in other countries have had serious technical problems. In a 1991 analysis of electricity-producing technologies, the Department of Energy's Policy Office ranked the ALMR program 21st out of 23 technologies in terms of energy contribution, economic growth, environmental protection and market and technical risk[1]. Unfortunately, despite a lack of economic justification or commercial interest, this program has cost taxpayers over $1.3 billion since 1986.

This program has now been re-packaged as the "Actinide Recycle" program. Its supporters claim it is an option for the management of nuclear waste. In fact, this program would create more problems than it solves, at enormous taxpayer and environmental expense. PIRGs and other environmental groups have long promoted recycling as part of the solution to our nation's growing solid waste problems. We are not fooled by the latest incarnation of the breeder reactor program, and neither was the U.S. House of Representatives, as demonstrated by their vote of 272 to 146 to eliminate funding for this program on June 24.

The Actinide Recycle and the ALMR program are not a solution to our nation's high level waste problem for three reasons: this process actually increases the amount of high and "low level" radioactive wastes, the technology is unsafe, and this process would be extremely costly.

The Actinide Recycle Program would reprocess spent fuel/from commercial nuclear power plants, to extract the actinides -- uranium, plutonium, neptunium, americium and curium. About one percent of the uranium and most of the other actinides, known as transuranics, would then be used as fuel for ALMR's. The spent fuel from the ALMR's would be periodically removed, reprocessed again and fed back into the reactor, hence the term "recycling". The justification for this process is that, over a long period of time, the inventory of plutonium and other transuranics will decrease through fissioning in the ALMR. This approach is neither quick nor easy. Scientists from Lawrence Livermore National Laboratories estimate that it would take at least one thousand years operating as many as forty ALMR's to reduce the transuranic inventory by a factor of one hundred[2].

THE ACTINIDE RECYCLE PROGRAM WOULD INCREASE THE AMOUNT OF RADIOACTIVE WASTE

It is important to note that less than 2% of the original spent fuel would actually be separated for use in the ALMR. 98% of the original spent fuel, which would be mixed with toxic chemicals such as cadmium and additional uranium, would still have to be stored. Because of the chemicals added in reprocessing, Argonne's own technical documents show that for each metric ton of spent fuel which is reprocessed, at least 1.3 metric tons of high level wastes are generated[3]. If the recovered uranium (which may be isotopically unfavorable for use in reactors[4]) is included, then at least 2.3 metric tons of high level waste would have to be disposed of from reprocessing one metric ton of spent fuel[5].

Thus, the reprocessing step alone would increase the original amount of high level wastes by a factor of 1.3 to 2.3. These would need to be stored in a geologic repository or by some other method. Reprocessing would also generate large amounts of so-called low level wastes. Millions of cubic feet of "low level" radioactive waste would be generated from reprocessing just the existing commercial spent fuel[6]. This would probably have to be stored on-site. The decommissioning of many generations of ALMRs would result in additional radioactive wastes which would also likely be stored on-site.

Therefore, far from helping reduce the amount of radioactive waste in this country, this program would dramatically increase the amount of both high and "low level" radioactive wastes. In addition, it would necessitate the long-term storage of spent nuclear fuel above ground for later use in the process.

ALMRs ARE UNSAFE

Proponents want us to believe that this new generation of breeder reactors is "inherently safe". In fact, PRISM, the ALMR design being developed by General Electric originally stood for Power Reactor Inherently Safe Module[7]. No energy production from atomic fission is inherently safe, and in fact, GE has changed the name to Power Reactor Innovative Small Module[8]. In addition to basic nuclear safety issues associated with traditional light water reactors, the Advanced Liquid Metal Reactor (ALMR) carries additional safety risks. Unlike traditional reactors, ALMR's are cooled by sodium which reacts explosively with air and water. In addition, loss or boiling of the sodium coolant can speed up the nuclear chain reaction, leading to so-called "core disruptive events" which are, in essence, nuclear explosions[9]. Similar reactors in other countries have had technical difficulties relating to the sodium coolant. For example, the Superphenix breeder reactor in France has been shut down, perhaps permanently, because of sodium leaks[10].

Moreover, there are questions about the integrity of the research relating to the safety of the ALMR fuels, and the management of the project overall. A metallurgical engineer who worked on this research at Argonne National Laboratories in Idaho, Dr. Jim Smith, has raised concerns that ANL was citing nonexistent data on fuel melting, an issue that is critical to reactor safety (see Attachment A).

THE PROGRAM WOULD GREATLY INCREASE THE COSTS OF GEOLOGIC DISPOSAL WITH DUBIOUS BENEFITS

Lawrence Livermore National Laboratories estimates that just reprocessing the spent fuel from existing reactors would more than triple the costs of geologic disposal[11]. Dr. Frank von Hippel of Princeton University estimated that if all costs are included, the fissioning of separated actinides from existing reactors would cost $400 billion, with only half of the costs recouped from the sale of electricity[12].

Even if there are no catastrophic accidents during the thousands of years of operation required to meet the transuranic inventory-reduction goals, the expense, additional wastes and safety risks posed by this program outweigh the uncertain benefits of removing most of the transuranics from commercial nuclear spent fuel. For the type of repository now planned, long-term human health concerns center around the possibility of radionuclides leaching out of the waste and finding their way to the surface. Because they are relatively insoluble, the transuranics (plutonium and minor actinides) do not dominate long-term risks. It is the long-lived fission products such as iodine-129 (half-life 17 million years), cesium-135 (3 million years), and technetium-99 (212,000 years)[13], which pose the highest long-term human health hazard. These long-lived fission products are not addressed by the Actinide Recycle program. Moreover, the transuranics can never be completely removed from the wastes which eventually reach the repository. According to Dr. Thomas Pigford, reducing the actinide inventory does not necessarily reduce the radiation-dose risk from the actinides[14]. Because they are so insoluble, the release rate of the actinides will not decrease unless actinide concentrations in the spent fuel are reduced to well below the current estimates of what can be achieved by the Actinide Recycle program.

CONCLUSION

A recent report by independent scientists from Lawrence Livermore National Laboratory concluded that there "remain no cost or safety incentives" for the actinide recycle concept as part of the high level waste management system[15]. According to the National Academy of Science the "...potential to alleviate some of the waste disposal problem... is not considered justification for advancing the advanced LMR development program.."[16] Even the American Nuclear Energy Council sees"..no benefit in considering transuranic burning as a waste solution for current fuel."[17]

DOE has not compared this program against other methods of waste disposal. In addition, if continuation of this program is justified as a nuclear waste management option, then it should be funded out of the Nuclear Waste Fund.

We believe there is no justification for this program in any form. We have already burdened ourselves and future generations with the task of cleaning up 140,000 cubic meters of high level wastes from reprocessing spent nuclear fuel for weapons[18], storing the spent fuel from existing commercial reactors, and decommissioning these reactors as they age. Solving nuclear waste problems by building systems which create more waste does not make sense. Independent scientists, the nuclear industry, and the U.S. House of Representatives do not support the ALMR and Actinide Recycle program. Even if it worked, this program would trade reduction in transuranics, which represent a tiny percentage of spent fuel from commercial reactors, for large increases in high and "low level" reprocessing wastes, safety risks from both reprocessing and ALMR operation, and increased risk of nuclear proliferation, all at enormous expense. We should not condemn future generations to this expensive, dangerous program.

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CORPORATE CRIME REPORTER

ASBESTOS CASE REVEALS WESTINGHOUSE MEMO RECOMMENDING THE DESTRUCTION OF "SMOKING GUN" DOCUMENTS

A New Jersey Judge allowed the release of an internal Westinghouse memo last month from the company's in-house counsel, who recommended that the company destroy "smoking gun" documents that might hurt Westinghouse in future litigation.

The 22-page untitled memo lists the types of documents Westinghouse has on file in the Industrial Hygiene Department which "critiques and criticizes" the company's manufacturing operations. The memo, written by Jeffrey Bair, in-house attorney and C.W. Bickerstaff, Manager of Corporate Industrial Hygiene, contains a review of and inventory of materials from Westinghouse dating back to the early 1930s. Although there is no date on the memo, Westinghouse lawyers told the Judge that the it was written in 1987.

According to the memo, "The majority of the documents in Industrial Hygiene's files are potential 'smoking gun' documents." It recommended a systematic destruction of numerous "smoking gun" documents, produced prior to 1974, that would be relevant in all toxic tort litigation Westinghouse might be involved in.

On January 14, 1992, Judge Jack Lintner of the Middlesex County Superior Court ordered that the seal be lifted on a series of asbestos court proceedings involving Westinghouse. Westinghouse appealed the decision, but Lintner denied the appeal on February 4, 1992 and the documents were released.

Westinghouse has been trying to keep the memo under seal, arguing that it should be considered privileged information because it involved confidential communication between attorney and client. However, Lintner ruled that the crime/fraud exception to attorney/client privilege allowed the documents to be released.

The memo has turned up in asbestos litigation in at least four states -- Mississippi, North Carolina, New Jersey and Texas. The Mississippi case is scheduled to go to trial in April. The Texas case is in trial now, and the New Jersey case is in discovery, according to Chris Placitella, an attorney representing the plaintiffs in the New Jersey case.

Westinghouse wanted to get rid of the documents prior to 1974, because "they're not as helpful as the ones after 74," Placitella told *Corporate Crime Reporter*.

"The proposal was never implemented and as far as we were able to determine -- no documents were destroyed as a result of the proposal," Jim Schmitt, of Westinghouse, told *Corporate Crime Reporter*. "In fact, we didn't even discard the memo." Westinghouse insists that the destruction of documents was never part of the company's policy.

Placitella said that he cannot comment on whether he believes that documents were destroyed until he takes further discovery in the New Jersey case.

"The significant issue is not the memo itself, although it's juicy in its own right, but the [Court] transcript, where they [Westinghouse] indicate that they believe it is proper to destroy the document, so long as it doesn't immediately threaten current litigation," Placitella said. "Although I might have my suspicions I never thought I would hear that kind of thing in a court room."

"Clearly it [memo] is aimed at stymieing or preventing the discovery of litigation that could be utilized against Westinghouse in future litigation," Judge Lintner wrote in a January 14, 1993 ruling. "It seems to me that this document specifically deals with hiding the truth, with discarding documents that might get to the truth. And as such, it seems to me to be somewhat deceitful. It seems to fall within the crime/fraud exception, and seems to be perhaps even tortious in nature, perhaps if one were to consider the tort spoliation."

Westinghouse lawyers argued that the company was justified in destroying documents that might harm the company in future litigation.

Attorney Raymond Tierney, of Westinghouse argued to Judge Lintner, "If I advise a client, get rid of this stuff -- it may ultimately come back to haunt 'ya in litigation that could take place 15 years from now, I -- and you and I may never agree to this because ultimately somebody's going to have to decide whether that advice is correct or not, there is nothing wrong and I represent to the Court that there are document destruction programs all over the United States that among other things deal with this issue."

Lintner ruled that that kind of advice given by the Westinghouse in-house counsel was "wrong and improper."

(See WESTINGHOUSE, page three)

counts of bank fraud, late last month. Hundreds of local investors lost millions because of the fraud.

The indictment alleges that the defendants used the assets of the bank holding company and its five subsidiary banks for their own financial gain and that of family members. The indictment followed an intensive 17-month federal investigation.

"This prosecution is the latest in a series of major bank fraud cases investigated by federal authorities," U.S. Attorney Stephen Higgens said. "This is a case which has received attention nationally as well as locally because of the prominence of the officials charged and the potential loss," Higgens said prior to the couple's suicide.

First Exchange Corp. (FEC) is based in Cape Girardeau, Missouri and has five subsidiary banks. In May 1992, the Commissioner of Finance for the State of Missouri took possession of the banks and declared them insolvent.

Donald Chilton had resigned his position as chairman of the board-CEO of FEC on July 31, 1991, because of an examination conducted by the Federal Reserve Bank of St. Louis, and examiners from the Federal Deposit Insurance Commission and Missouri Division of Finance.

According to the indictment, Chilton told bank employees to lie to Federal Reserve regulators if irregularities were discussed. The Chiltons are involved in many lawsuits and countersuits with managers at the bank. According to the indictment, the FEC's funds were allegedly used to cover bad investments, to make loans to corporations formed by Donald and Bill Chilton, and to make loans to family members.

The indictment alleges that the defendants engaged in four separate schemes to commit bank fraud that started in January 1986 and continued until July 1991.

In the first scheme, Crawford, while working for Crews and Associates a securities firm that bought and sold bonds on behalf of FEC banks, allegedly used wire transfers to cover-up losses incurred by Donald and Bill Chilton.

The second fraud scheme was conducted through Mid-America Management (MAM), a company formed by Bill and Donald Chilton. In early 1987, MAM purchased the Sikeston Ramada Inn and The Drury Inn in Springfield, Missouri. The motels were mortgaged with two loans totalling $6 million. MAM obtained the loans from FEC banks, and made false statements to acquire the loans.

In the third scheme, Donald Chilton I
in several businesses operated by his bro
Regulations imposed by the banking ind
required Donald Chilton to reveal any ir
had in those companies, to banks and th
Reserve Bank.

In the fourth scheme, Donald Chilton
to his sister and brother-in-law without l
the bank management or the board of di
the familial connections. Chilton loaned
more than $380,000 which she in turn u
property from Donald Chilton. Chilton n
disclosed that he was the owner of the p

INTERNAL DOE DOCUMENTS SHOW EFFORT TO SUPPRESS REPORT WHICH FOUND SCIENTIFIC MISCONDUCT AT DOE LAB

A series of internal Department of Energy (DOE) documents show that the agency worked to suppress a report written in support of a whistleblower's allegations of scientific misconduct at Argonne National Laboratory (ANL) in Idaho.

Documents received by the whistleblower, Dr. Jim Smith, from a Freedom of Information Act (FOIA) request, show an internal struggle within DOE. On the one hand, the ANL lab sought to suppress the DOE report, and on the other, Steven Blush, director of the DOE's Office of Nuclear Safety (ONS) and author of the report, sought to get the report released publicly.

The uncovered documents include a letter from then DOE Secretary James Watkins praising Smith for efforts to improve management practices at Argonne. Watkins approved the release of the report on November 19, 1991, and a mock press release was written in December, praising Smith. ANL succeeded in delaying the release of the report until early April 1992. Neither the press release, nor the letter from Watkins to Smith were ever released.

"Here's a case of a cover-up at the very highest levels of DOE, of bad science on one of the most prominent nuclear reactor programs, and I think that this has to be exposed," Smith told *Corporate Crime Reporter*. "This was supposed to be an independent assessment of the work, instead it turned into Argonne's reply to that report."

The DOE report, released in May 1992, supported allegations by Smith, who had worked at the ANL as a metallurgist from April 1988 to

August 1990 when he resigned. Smith alleged that the lab was incompetent in its research of the Integral Fast Reactor (IFR), that the lab made fundamental errors, published false and misleading accounts of the work, and that the Lab's attitude was antithetical to quality science.

Smith found that ANL was citing nonexistent data to support calculated fuel-melting temperatures that he needed to use in reactor experiments. Smith expressed his concerns through a memo, after which he was told that he had no future at ANL and would be terminated in 1993. Smith then declined to design the fuel-melting temperature experiments because the validity of the data was questionable. ANL then fired Smith.

"I'm not anti-nuclear at all, in fact I'm a supporter of such work, but the only way the taxpayers are going to get their money's worth is to do good work, and the only way the public can make an informed choice on whether we can go this route is by really having honest information on it," Smith said. "I think DOE was trying to subvert those processes."

The DOE found:

* Some ANL work, published or otherwise disseminated, was misleading and, pursuant to ANL policy, was not retracted, corrected or qualified even when errors or serious questions about its validity were discovered;

* Smith accurately described a scientific culture that was oversensitive to internal politics, real or imagined slights, and other considerations;

* Smith's job was threatened because of a memo that was critical of the laboratory's methods;

* An ANL manager accused Smith of being abrasive with his peers and suggested that he look for work elsewhere, after Smith expressed technical concerns.

The documents Smith received are primarily from October 1991 through December 1991. Smith said he is trying to find out what was happening within DOE from January 1992, until early April.

On October 28, 1991, a memorandum from John Easton, General Counsel at DOE, said that the draft report should not be released because, "disclosure of the draft report at this time could lead to public confusion if the views expressed in the draft report ultimately are not adopted by the decision-maker."

The Office Nuclear of Safety (ONS) responded in a letter by Blush on November 4, 1991, "The fact that a draft report is not a final report is no reason not to ask appropriate parties to review the draft report for factual accuracy . . .most people are not confused about the difference between a draft and a final report."

The General Counsel argued that releasing the draft of the report to Dr. Smith for review, "is more likely to be viewed as a public release, especially if the copy provided is not expurgated, because Mr. Smith presently has no standing other than as a private citizen."

ONS responded, "The conclusion one would draw from this is that a person who, as a result of raising a concern, has been retaliated against with loss of his or her job no longer has standing in the adjudication or resolution of that concern because they have lost their job."

A November 25, 1991, letter from Alan Schriesheim, director of the ANL, in Chicago, to Energy Secretary James Watkins, shows an effort by the lab to block the release of a possible press statement praising Smith. "Such an action ignores both the review processes of the Laboratory and Mr. Smith's performance during his employment at Argonne National Laboratory," Schriesheim wrote.

"Mr. Smith failed to carry out his assigned responsibilities," Schriesheim said. "In fact, he refused to respond to direct management requests to develop work schedules. To publicly commend him is to publicly declare that the hours Argonne management spent meeting with him, discussing and considering his objections were, at best, insincere. Thus, to publicly praise Mr. Smith is to reward a man who failed to do his job."

"Yes, the meetings I had with Argonne were insincere, they were rigged," Smith said. "They were chartered by people who had already taken the position in writing to DOE that there was no problem there and had conflicts of interest in conducting those meetings."

Schriesheim requested a delay in the release of the report to provide more detailed responses to the report's allegations.

"There was a lot of internal manipulating going on by Argonne Laboratory, according to these documents," Tom Carpenter, of the Government Accountability Project (GAP), told *Corporate Crime Reporter*. "The documents show Argonne was instrumental in delaying the release of the report, and manipulating the report's findings to make it less negative toward them. This is all kind of phenomenal."

Blush responded to Schriesheim in a December 2, 1991 letter to Watkins, "One might get the impression from Schriesheim's letter that Argonne either had never been offered the opportunity to provide 'factual statements' in response to the NS investigation, or had provided them but they were ignored. In reality, the Lab had four separate opportunities to provide the 'factual information' it is now requesting time to prepare."

"At no time has NS received anything from the Lab that would support the view that there are any factual errors in the report," Blush wrote.

A December 17, 1991 memo from John Easton, to Steven Blush, recommended that a third party "personally review the record prior to the Department taking any public course of action." Easton wanted an oral review by Blush and Schriesheim to the Secretary.

In a December 18 memo Blush responded that Easton, "fundamentally misunderstands the NS role in this matter and is ill advising the Secretary. . .NS is the independent 'third party' you seem to believe the Secretary needs to have review this matter. NS is in no way an advocate for Dr. Smith nor the prosecutor of Argonne, as your memos seem to imply."

"Suppose the NS investigation had concluded that Smith had no grounds for his complaint. Would you be arguing that the Secretary should invite Smith to come before them to argue his case?" Blush asked.

"The time for memo writing is long past, and I am not anxious to continue it," Blush wrote. "The report is a good, sound report by an independent investigative unit within the Department of Energy and should be released without further ado. The longer we sit on it, the more we encourage others to draw the conclusion that the Department is suppressing it."

DID SUPREME COURT GIVE SAFE HARBOR TO ACCOUNTANTS AGAINST RICO PLAINTIFFS?

When the Supreme Court handed down its decision in *Reves v. Ernst & Young* last week, newspapers declared a victory for accountants and a defeat for consumer rights. The *Wall Street Journal* headline read "High Court Gives Accountants a Shield Against Civil Racketeering Lawsuits." One consumer advocate called the decision "the death knell for civil RICO."

Not so fast, says G. Robert Blakey, a professor of law at Notre Dame Law School.

"This opinion stands for the proposition that an accounting firm providing accounting services to a legitimate business, absence knowledge that the legitimate business is being run corruptly, cannot be brought within RICO," said Blakey, who drafted the statute. "But nobody that I know ever thought that an accountant without actual knowledge of the illegal behavior within the enterprise could be held responsible [under the Racketeer Influenced and Corrupt Organization Act (RICO)]"

RICO makes it unlawful "for any person employed by or associated with [an interstate] enterprise. . .to conduct or participate, directly or indirectly, in the conduct of such enterprise's affairs through a pattern of racketeering activity. . ." The accounting firm of Arthur Young, Ernst & Young's predecessor, engaged in certain activities relating to valuation of a gasohol plant on the yearly audits and financial statements of a farming cooperative. The cooperative filed for bankruptcy, and the bankruptcy trustee brought suit alleging that the activities in question rendered Arthur Young civilly liable under RICO to holders of certain of the cooperative's notes.

The lower court applied Circuit precedent requiring, in order for such liability to attach, "some participation in the operation or management of the enterprise itself." The lower court ruled that Arthur Young failed to meet that test and granted summary judgement in its favor on the RICO claim. The Court of Appeals affirmed.

The Supreme Court held, by a vote of 7-2, that one must participate in the operation or management of the enterprise itself in order to be subject to the RICO liability.

Blakey represented Trial Lawyers for Public Justice in an amicus brief on behalf of the plaintiffs in the *Reves* case.

"We argued that the operation or management test was too narrow," Blakey said. "We argued that if this test was adopted, it would potentially lead to an upper-level-management-only rule. While the court adopted a operate or manage test, it was very express in saying that this was not upper management only test. So, while the TLPJ lost their construction of the word 'conduct,' they won a broader construction of the management test."

"The bad guys wanted to get from the court an upper management only interpretation of the word 'conduct' in RICO," Blakey told *Corporate Crime Reporter*. "Had they secured it, lower level people in licit and illicit enterprises would have gone scot-

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EEI **EDISON ELECTRIC INSTITUTE**

60th Anniversary 1933 - 1993

August 20, 1993

Mr. Dwight E. Shelor
Associate Director, Systems and Compliance
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue, S.W.
M/S RW-30
Washington, D.C. 20585

Subject: "Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste, A Report to the President and Congress in Accordance with Section 803 of the Energy Policy Act of 1992", dated June 1993

Dear Mr. Shelor:

The Edison Electric Institute/Utility Nuclear Waste and Transportation Program (EEI/UWASTE) is pleased to provide comments to the Department of Energy (DOE) concerning its report in response to Section 803 of the Energy Policy Act of 1992. EEI/UWASTE has reviewed DOE's "Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste, A Report to the President and Congress in Accordance with Section 803 of the Energy Policy Act of 1992", dated June 1993 (Report). EEI/UWASTE continues to believe that the content of the Report exceeds the assessment of current waste management plans called for in Section 803 of the Energy Policy Act. However, EEI/UWASTE agrees with DOE's conclusion that "current waste-management programs and plans are adequate for any additional volumes and categories of nuclear waste produced by new nuclear plants."

EEI is the association of the nation's investor-owned utilities. Its members generate approximately 78% of the nation's electricity. EEI/UWASTE is a separately funded activity within EEI and represents the vast majority of electric utilities with nuclear energy programs. EEI/UWASTE takes actions necessary to ensure that safe, environmentally sound, publicly acceptable, cost effective radioactive waste management and disposal, and nuclear material transportation systems are maintained and developed in a timely manner.

In addition, while EEI/UWASTE believes that the majority of its comments, dated April 6, 1993, on the prior draft Report remain valid, EEI/UWASTE would like to reiterate its objection to Nuclear Waste Fund monies being used to perform studies not related to commercial spent fuel and outside the jurisdiction of the Office of Civilian Radioactive Waste Management. Thus, any future activities by DOE to more accurately project potential volumes or categories of high-level radioactive waste resulting from DOE's waste stabilization and disposal programs should not be funded by utility industry payments into the Nuclear Waste Fund.

Please feel free to contact us if you would like to discuss further the viewpoints of EEI/UWASTE on the Report.

Sincerely,

Steven P. Kraft
Director, Nuclear Waste
and Transportation

SPK/cjh

cc: Messrs.:

Lake Barrett, DOE
Robert Bernero, NRC
Lawrence Weinstock, EPA

ENVIRONMENTAL COALITION ON NUCLEAR POWER

Dr. Judith Johnsrud, Director

433 Orlando Avenue, State College, Pa. 16803 814-237-3900

August 19, 1993

Mr. Dwight E. Shel[l]or
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue SW
Washington, D.C. 20585

Dear Sir:

The following comments are submitted on behalf of the Environmental Coalition on Nuclear Power (ECNP), a non-profit, public-interest organization based in Pennsylvania. They address DOE's draft" Section 803 Report" to Congress concerning the adequacy of DOE management plans for spent fuel and high-level radioactive wastes that may be generated in the future.

However, I wish to reserve the opportunity to supplement these comments when DOE complies with my request for a copy of the draft document under consideration. I had requested by telephone call to your office on August 13, on the day that I was first notified about it. The receptionist or secretary who took my call, in your absence, assured me that the draft report would be sent to me immediately. It is now a week later; the comment period, I was informed, is set to end on August 20; the draft Section 803 Report has not arrived. I have only indirect summaries of its content upon which to offer our comments on a very important matter. For these reasons, <u>I respectfully request that the report be sent to me posthaste and that DOE extend the comment period for an additional 30 days.</u>

As representative on ECNP on the Pennsylvania State Advisory Committee on Radioactive Waste (although I am not speaking for the committee or the Commonwealth), I am actively involved in the decision-making processes attendant upon the safe management and isolation of commercial "low-level" radioactive waste in our state, which is the designated host for the Appalachian States Compact. The subject of the Section 803 Report is clearly pertinent to our concerns.

We concur with, and incorporate by reference, the group comments submitted by other environmental organizations, including Nuclear Information and Resource Service, Union of Concerned Scientists, Sierra Club, Physicians for Social Responsibility, Environmental Action, Critical Mass, U.S. Public Interest Research Group, Greenpeace, Natural Resources Defense Council, <u>et al</u>.

This draft report clearly is not adequately responsive to the intent of the Congressional directive in the 1992 Energy Policy Act. A fundamental factor that seems to have ignored by DOE is the increasing level of difficulty in storing, managing, and permanently sequestering radioactive wastes from the biosystem as the total quantity of wastes generated continues to increase. Our national economy cannot support proper control of the rapidly rising inventory of spent fuel and high-level wastes that DOE purports to account for. It is sheer idiocy, if not downright criminal, for this agency -- itself responsible for so much dangerous radioactive and chemical waste contamination nationwide -- to suggest that any additional quantities of spent fuel and high-level, or "low-level," waste be produced given the painfully obvious inability of DOE or anyone else to "dispose" of that which already exists.

Realistic environmental analysis appears to be woefully absent from the draft report. All aspects of these impacts will be worsened if the volume and curie content of radioactive wastes is allowed to continue to mount.

The basic issue is the adverse health and safety effects of exposures of biological organisms and systems to ionizing radiation. It is now recognized, and admitted, by the National Academy of Science National Research Council Committee on the Biological Effects of Ionizing Radiation (1990 BEIR V Report) that there is no safe threshold of exposure to ionizing radiation.

Of even greater significance is recent research information on the deleterious effects of low dose and chronic low-dose exposures upon the functioning of the body's immunological system, particularly in young children (Burlakova, chair, et al., [former] Soviet Academy of Sciences Scientific Council on the Problems of Radiation Biology, 1991). Via ingestion and inhalation pathways, internal emitters are now understood to undermine the ability of the immune system to ward off a great variety of diseases. Ill health and failure to thrive among the young will constitute both a societal and economic burden of enormous proportions; such costs must be taken into account as real effects in the future in consequence of the production of radioactive wastes.

In addition, a host of non-cancer effects have now been observed among radiation recipients; and advances in molecular radiation biology are beginning to provide explanations of radiation injury mechanisms (Boardman, Radiation Impact: Atoms to Zygotes, Center for Atomic Radiation Studies, 1992). Long-lived alpha-emitting particles have been shown to have a far greater relative biological effectiveness than had previously been assumed, or than is recognized in existing radiation safety requirements and public protection standards.

Rather than hope (or lobby) for any relaxation of regulatory standards or requirements, DOE should of its own volition radically increase its own rules for the period of isolation, standards for future exposures, and design requirements for spent fuel and HLW. The first step in successful management of the wastes already generated is cessation of production of more waste, and this action DOE should take immediately and should recommend to the Congress.

We urge the Secretary to recommend that the President create a truly independent commission (with a preponderance of ordinary affected citizens and experts selected from and by from the environmental community) to review and recommend changes in the entire program for the management of all forms or radioactive waste. It is distressingly obvious that the current system has failed. It is far better, and safer, to acknowledge that failure and attempt to do better. In addition to halting waste production, DOE should halt the existing waste programs for which it bears responsibility, pending the completion of a full independent review and the Congressional or Administrative actions necessary to improve the control of all radioactive wastes. Moreover, the suspicion has begun to dawn on the more perceptive that there may not be solutions to the problem of radioactive waste. We leave a terrible legacy.

Sincerely,

Judith H. Johnsrud, Ph.D.
Director

CERTIFICATE OF SERVICE

I, Judith H. Johnsrud, affirm that the accompanying letter dated August 19 containing comments of the Environmental Coalition on Nuclear Power on the DOE Draft Section 803 Report to Congress on Adequacy of Management of Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste was deposited in the U.S. Mail, first class, postage paid, on August 20, 1993.

Judith H. Johnsrud

Judith H. Johnsrud, Ph.D.
Director

NUCLEAR WASTE REPOSITORY OVERSIGHT PROGRAM

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August 26, 1993

Mr. Dwight Shelor
Associate Director
for Systems and Compliance
Office of Civilian
Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue SW
Washington, D.C. 20585

Mr. Shelor:

Esmeralda County would like to offer the following observations and comments on the draft report "Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste."

Section 803 of the Energy Policy Act of 1992 requires the Office of Civilian Radioactive Waste Management to:

> ...examine any new relevant issues related to management of spent nuclear fuel and high-level radioactive waste that might be raised by the addition of new nuclear-generated electric capacity, including anticipated, increased volumes of spent nuclear fuel or high-level radioactive waste, any need for additional interim storage capacity prior to final disposal, transportation of additional volumes of waste, and any need for additional repositories for deep geologic disposal.

By developing different scenarios, the Report establishes that the reference case exceeds 100,000 metric tons, which is already well above the statutory limit for Yucca Mountain of

70,000 metric tons. Despite this, the Report concludes that the decision regarding a second repository needn't be reached until 2007. We do not agree that Section 161 of NWPAA is the prevailing legislation on the second repository. The more recently passed Energy Policy Act specifically requires examination of the need for additional repositories. The Report suggests that the proposed first repository could hold increased volumes of waste since the limitations are statutory rather than technical. However, it is premature to assume the law would be changed. Additionally, no mention is made of contingency plans should Yucca Mountain prove unsuitable.

The Report assumes that many major issues can be looked at later and that current programs and plans are adequate. The General Accounting Office reported that the current time line for the proposed repository is slipping to 2020. Yet the Report doesn't reflect this. The Report leaves many unanswered questions about the total inventory. The figures are confusing about the miscellaneous wastes not included in the scenarios and the amount of defense wastes is yet to be determined.

This is especially true in the section on transportation (6-9) which is two short paragraphs in its entirety although it is specifically called out for examination in Section 803. The Report avoids transportation issues and states that there will be ample opportunity later to develop casks. Increased waste generation indicates the need for more cask development and the greater volumes of waste will add to the number of shipments. This may create greater impacts on highways and communities along the routes. It will also increase the risk of accidents and perceptions of risk and further impact local first responders. The increased impacts on transportation routes may require revisiting the choice of modes for transport. It may also raise questions about the need for and location of an MRS facility---specifically whether an MRS should be located near generating plants with dedicated train shipments to the repository.

The interim storage issue is another item that the Report assumes can be looked at later (6-8). The Report is sanguine about the ability to either leave the waste on site or easily identify another site. The search for an MRS has been ongoing since 1983 when DOE started looking for a site and then announced in 1985 that Tennessee had been chosen. We still have no site for interim storage ten years later, and resistance is growing against extended on-site storage. The Report may be too optimistic in assuming that the siting problem could be readily resolved.

Esmeralda County also wishes to offer the following comments on specific sections of the Report:

1. Introduction:

The introduction is very scanty. The nuclear waste issue is tremendously complex and the introduction should have given more details on some of the background of issues involved in the current program, including transportation, monitored retrievable storage vs. at-reactor storage, statutory limitations on the proposed repository and some concrete idea of the volume amounts if no new reactors are licensed.

2. Cases on High-Level Radioactive Waste Generation:

The figures for the canisters at Hanford are confusing and speculative. In a presentation by W.C. Miller to the NWTRB Engineered Barrier System Panel meeting in Richland Washington on May 11, 1992 on Pretreatment Technology Development, an overhead was presented showing that depending on the degree of pretreatment, the number of canisters shipped to Yucca Mountain could exceed 200,000.

3. Partitioning and Transmutation Case for Spent Nuclear Fuel...

This entire twelve page section appears to be an advertisement for a new technology. The section is very detailed and seems to emphasize DOE's interest in advancing the case for partitioning and transmutation. It is unlikely that these new technologies will become part of the waste management strategy. Additionally, we understand there could be criticality issues involved in these new technologies and that the wastes may not be appropriate for geologic disposal.

In conclusion, Esmeralda County believes that DOE has not made the case that its current programs and plans are adequate. Some Nevadans perceive this Report as a first attempt by DOE to change the NWPAA again to make Yucca Mountain the sole repository regardless of the volume of waste to be disposed. The Report should not be based on the assumption that Yucca Mountain can absorb all existing waste in addition to waste from new reactors. Nor should it be based on the assumption that the law would be changed to permit this. Postponing a decision on a second repository until 2007 is poor planning. Contingencies need to be developed and backup sites may have to be determined. At this point it is not even sure that Yucca Mountain will be determined to be suitable. The Report also has to address interim storage more thoroughly, and the effects on transportation routes, shipping containers, and modes of transport.

We encourage you to consider these comments and those of other interested parties in revising your Report for submission to the President and Congress.

Sincerely,

Juanita Hoffman

Juanita Hoffman
Program Director

GE Nuclear Energy

Advanced Reactor Programs
General Electric Company
6835 Via Del Oro M/C, San Jose, CA [illegible]
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August 20, 1993

XL-270-930159

Mr. Dwight E. Shelor
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Subject: **Comments on the Report to the President and the Congress in Accordance with Section 803 of the Energy Policy Act of 1992 on the "Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste"**

Dear Mr. Shelor,

We are pleased to provide comments on the subject report. First, the report is a well balanced view of the spent nuclear fuel and high-level waste situation. You are to be commended for appropriately including information on partitioning and transmutation and particularly the planned implementation of the Advanced Liquid Metal Reactor Actinide Recycle System. This (ALMR) topic should not be ignored, as some have proposed, in the context of this report because of its potential importance to long-term waste management.

Second, we recognize that information for the report was derived from several sources and the waste numbers could be more specific and not indicate such a wide range. However, the ranges are acceptable and the "final" results could be significantly different than any specific values that could be projected today. There is one area of the report that is misleading, however, Table 6-1 and Figure 6-1. The total waste packages are shown in the Advanced Liquid Metal Reactor (ALMR) scenario but are not shown for the reference and upper-bound scenarios. This indicates a relatively higher number of packages for the ALMR scenario than for the other scenarios, a conclusion which is not correct. The number of waste packages for disposing of spent fuel should be included for consistency of comparisons.

Sincerely yours,

Marion L. Thompson

Marion L. Thompson
(408)365-6481

MLT/seg

cc: F. Goldner (DOE)
P.M. Magee (GE)
J.E. Quinn (GE)

State of Idaho
DEPARTMENT OF HEALTH AND WELFARE
Office of the Director

CECIL D. ANDRUS
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August 19, 1993

Mr. Dwight E. Shelor
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Mr. Shelor:

The State of Idaho has reviewed the draft report to Congress on the *Adequacy of Management Plans for Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste* (Report). The Report analyzes management of additional spent fuel from nuclear-generated commercial electrical capacity. Governor Andrus earlier commented on the annotated outline, that the Report goes beyond the Congressional mandate and could bias actions to manage the Nation's nuclear waste. This concern remains. See Attachment 1 (Andrus Comments).

The Report concludes "current waste-management programs and plans are adequate for any additional volumes and categories of nuclear waste produced by new power plants." Report at ES-1. This conclusion is based upon flawed assumptions and an unrealistic view of the effectiveness of current plans.

The reference case for spent nuclear fuel (SNF) projects 85,700 metric tons of SNF will be discharged by existing light water reactors (LWR) through 2030. Report at 3-3. The Upper Reference Case assumes new orders for commercial reactors will be made after 1992. The cumulative amount of SNF discharged through 2030 is 115,800 metric tons. Report at 3-6. This leaves an increase of 30,100 metric tons of SNF discharged through 2030 attributed to new commercial reactors orders. Since a second repository has not been sited, the capacity of the first repository is limited to 70,000 metric tons. 42 U.S.C § 10134(d). The amount of SNF anticipated under the Upper Reference Case and the reference case scenarios each exceed this limit. This does not take into account the other wastes, such as greater-than Class C low level waste and waste from weapons dismantlement, destined for geologic disposal.

DOE assumes the development of the waste-management system is at an early stage, allowing ample opportunity to adjust for changes in needs. Report at 8-1. DOE did not consider waste emplacement capacities, facility designs or facility cost estimates in reaching its conclusion. Report at 6-6.

In other reports, OCRWM task forces have recommended significant program changes in order to manage existing, prioritized spent fuel. For example, the Alternative Strategy for OCRWM suggests removing the statutory interdependencies between the geologic repository and the monitored retrievable storage facility. Alternative Strategy at 2. Similarly, the capacity limit for the first repository has also been challenged and suggestions made to remove this requirement.

Since 1975, DOE has been charged with siting and constructing a geologic repository for SNF. 1982 *United States Code Congressional & Administrative News* at 3795. Its efforts have resulted in skyrocketing costs, siting delays and dramatic schedule slippages. Latest estimates indicate $874 million have been spent on Yucca Mountain Project since 1990. Latest DOE estimates project $6.3 billion in year-of-expenditure dollars will be spent to complete the Project. Yucca Mountain Project is Behind Schedule and Facing Major Scientific Uncertainties, GAO/RCED-13-124 (May 1993), hereafter GAO Report. Originally scheduled to open in 1998, the best estimate for operation to begin appears to be 2015, five years after a decision on the second repository is made. GAO Report at 45; Report at 6-6. It is unlikely that Congress or the nation would allow another $6.3 billion experiment to go forward before the first repository can provide proven isolation of the waste.

DOE also assumes a second repository can be constructed and operational within 30 years. DOE's track record provides little confidence that a second repository could be completed in time, even allowing for lessons learned during the Yucca Mountain experience. The Waste Isolation Pilot Plant, Yucca Mountain, and siting the Monitored Retrievable Storage have all experienced substantial delays.

This Report should identify the limitations associated with current plans and the recommendations being developed by DOE to address the concerns. This less than candid approach in establishing baseline amounts and adequacy of current plans is disturbing. This report will seriously mislead our government into the erroneous conclusion that the management of spent nuclear fuel and high-level radioactive waste is progressing in a satisfactory manner. Plans now in place cannot handle current, known SNF inventory, much less projected increases in SNF inventories and other wastes destined for disposal. DOE should revise this Report to accurately reflect the state of nuclear waste management in this Nation.

Sincerely,

David L. Humphrey
Deputy Director

TAH/lvh

cc: Jon Carter, Special Assistant, Governor's Office
Steve R. Hill, Administrator, O.P.

PLANNING DEPARTMENT

YUCCA MOUNTAIN REPOSITORY ASSESSMENT OFFICE
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Peter Chamberlin
Planning Director

Brad Mettam
Project Coordinator

August 20, 1993

Mr. Dwight Shelor
Associate Director for
Systems and Compliance
OCRWM
U.S. Department of Energy
Washington, DC 20585

Dear Mr. Shelor:

We have reviewed the draft report entitled "Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste," which was mandated by Section 803 of the Energy Policy Act of 1992 (EPACT). Our review considered the basic questions raised in Section 803, and how the report responded to them.

Our principle concern is that the conclusion and main premises of the report appeared to beg the questions raised by Congress. Section 803 requires a report on:

> "whether current programs and plans for management of nuclear waste as mandated by the Nuclear Waste Policy Act of 1982 are adequate for management of any additional volumes or categories of nuclear waste that might be generated by any new nuclear power plants..."

The Department of Energy concludes that "current waste management programs and plans are adequate based on there being "sufficient time to modify the current programs and plans after the amount of additional waste to be generated by new plants is known" (page ES-1). This response is disingenuous because it argues that current programs are adequate because there is time to make them adequate. In our view, the question raised by Congress is not whether DOE has enough time to develop programs to address future waste management needs, it is whether current programs are now adequate to address such future needs.

DOE's response is meant to reassure Congress that all is well with current and future programs for disposal of radioactive waste, even if there is a considerable increase in volumes of waste. This reassurance belies both past and present experience with nuclear waste programs. It recalls the underlying assumption of nuclear power since the Manhattan Project -- that we can proceed with the development of current plans for nuclear generating capacity because there will be plenty of time to solve the nuclear waste disposal problem. The history of the single shell tanks at Hanford, the unfulfilled promises to move transuranic waste from Idaho to the WIPP site, and the about-to-be unfulfilled contractual obligation to accept title to utility wastes by 1998, all testify to the futility of thinking that "there is sufficient time" to deal with this problem.

There are also questions about whether current programs are adequate to deal with current volumes of waste (see comment #3 below). Since the 1987 Nuclear Waste Policy Amendments Act (NWPAA) was passed, there has been no amendment to the Mission Plan to describe current programs, and it seems increasingly unlikely that a monitored retrievable storage facility will be in place to take utility wastes by 1998, let alone a repository by 2010. Current estimates of disposal volumes are well in excess of the Congressionally mandated cap of 70,000 metric tons for the first repository.

Section 803 also requires that:

> "The report shall examine any new relevant issues related to management of spent nuclear fuel and high-level radioactive waste that might be raised by the additional new nuclear-generated electric capacity, including . . . any need for additional repositories for deep geologic disposal."

DOE's response is that more information is needed about the disposal capacity of the first repository and "only from that can we determine the need for a second repository" (page ES-2). The report goes on to say that the Nuclear Waste Policy Amendments Act of 1987 "requires an evaluation of the need for a second repository be done between 2007 and 2010", and "there is no need for an earlier evaluation" (page ES-2).

In this response, the Department is effectively declining to take a fresh look at the second repository, as mandated in Section 803, and is simply reiterating current policy. It assumes that Section 161 of NWPAA continues to prevail over more recent legislative requirements in Section 803 of EPACT. On the contrary, the more recent legislation always prevails in determining Congressional intent, and the current mandate is to look again at "the need for additional repositories for deep geologic disposal."

The need for a second repository is described as a statutory problem, not a technical problem (page 6-8). DOE maintains that before a decision can be made on the second repository, the capacity of the first repository must be determined by evaluating the available area, the thermal-mechanical characteristics of the rock and the heat-generating characteristics of the waste (page 6-8). DOE suggests that the decision should be dependent on the results of site characterization, but absent these results and given current capacity constraints in the statute, it would seem difficult to conclude that current programs are adequate.

The report seems to indicate that the current program plan is: (1) to determine the volume of waste; (2) to determine the capacity of Yucca Mountain; and then (3) to change the law to fit the disposal requirement. To base a plan on the assumption of flexibility in Congressional directives is risky. There is a certain audacity in reporting to Congress that current plans are adequate because of an assumption that Congress will change the law to fit the plan.

General Comments

1. There is an inconsistency in the logic of the underlying rationale for the sufficiency of time. Point #1 on page ES-1 suggests that there will be sufficient time to modify current programs and plans after the amount of additional waste to be generated by the new plants is known, since most of this increase would not occur until 2020 or 2030. Point #3 states that development of waste management systems are still at an early stage, "allowing ample opportunity to accommodate changing needs" (page ES-1). It continues: "major facilities for storage, transportation and disposal have not been sited, and final designs for their construction have not been developed." But by 2020 or 2030, when additional wastes volumes are known, we will have long since committed to the design and construction of a first repository and its ancillary transportation and storage requirements, if current estimates of completion by 2010 are to be believed. The Department seems to be saying that it is still early, so we have flexibility and do not need to plan for increases in waste volume that will not occur until after we have lost flexibility. This is a circular argument and should be re-examined.

2. Schedule assumptions have been notable for their inaccuracy throughout the nuclear waste program. It cannot be assumed that site characterization will be completed "in time to support the evaluation of the need for a second repository between 2007 and 2010" (page 2-8). If current GAO estimates are any guide, site characterization itself may not be completed until 2006 to 2013. It also may be optimistic to assume "an overlap of periods for waste emplacement and waste generation" when second repository construction is expected to be completed in 2040 but new reactor operation has not yet terminated in 2050 (page 6-6).

3. The report assumes that "current programs and plans are adequate for the reference scenario" (page 6-5). There is reason to question this assertion, based on the acknowledged excess of current volume estimates over the statutory limits for Yucca Mountain. The report maintains that: "although all of the scenarios developed in this report, including the reference scenario, generate more than 70,000 metric tons of spent nuclear fuel, it would not be prudent to make a decision on the need for a second repository based on these assumptions." We fundamentally disagree with the assertion for reasons outlined above in regard to the statutory limit.

The reference scenario assumes that approximately 100,000 metric tons of spent nuclear fuel and high-level radioactive waste will be generated (page 6-4). The report also states that "the scenarios did not take into account all sources of nuclear wastes that might be emplaced in a geologic repository" (page 7-1). The report asserts that these additional sources of waste are small and implies that they are not significant. But our reading of the report and our knowledge of additional categories of waste leads us to believe that actual volumes of waste to be emplaced in a repository will exceed those included in the reference case by at least 20 percent, which would call into question the adequacy of current plans to store all of the waste that is currently being generated at Yucca Mountain. The following categories of waste have not been included in the reference case:

1. High-level waste from the double-shell tanks at Hanford and Savannah River.

2. Core debris from Three Mile Island and any future core accidents (page 7-12).

3. Return of up to 12,000 spent fuel assemblies from overseas programs (7,000 metric tons) (page 7-13).

4. Waste from DOE research and production reactors (2,388 metric tons) (page 7-3).

5. Additional spent fuel resulting from the phase out of weapons-related reprocessing programs (volume unknown).

6. Decommissioning waste from dismantling nuclear weapons (volume unknown).

7. Decommissioning waste from defense high-level waste storage tanks (volume unknown).

8. Greater-than-Class C wastes (volume unknown) (page 7-3/4).

Given the expectation that the reference case may well exceed 100,000 metric tons, even without the above eight additional sources, the current plans for disposal cannot be said to be adequate. The current basis for waste management planning at Yucca Mountain is the Site Characterization Plan (SCP). This Plan was developed on the assumption that waste volumes could not exceed the statutory 70,000 metric ton cap. Thus, it would seem that the SCP is driving the design of a repository that is intended to accommodate at least 80 percent less waste than will be produced under the reference scenario, let alone the Upper Bound Scenario or the Advanced Liquid-metal Reactor Scenario.

4. The section on Interim Storage seems to express the same degree of (possibly) unwarranted optimism that "a final storage concept could be selected, designed, and licensed, and the facility built within 5 to 10 years of selecting the site" (page 6-8). Given the continuing difficulties with siting a monitored retrievable storage facility, and growing resistance to long-term on-site storage, it might be worthwhile to consider in more detail the "need for additional storage capacity prior to final disposal" that is requested by Congress in Section 803.

5. There is some question whether the Upper Bound Scenario and the Liquid Metal Reactor Scenario are realistic in view of current economic, regulatory and political constraints on new reactor development, and Congress' recent decision to cut back LMR research.

Thank you for the opportunity to comment on the Section 803 report.

Sincerely,

Brad Mettam
Yucca Mountain Project Coordinator

BM/jc

<u>Written Statement Prepared by Tom McGowan</u>
<u>Received by DOE July 20, 1993, Las Vegas, Nevada</u>

<u>Honorary Chairman</u>, Esteemed members of the Hearing Board, Department Heads, Key Staff, interested jurisdictions and members of the public:

My name is <u>Tom McGowan</u>. I am a native-born citizen of the United States of America, and an individual member of the public residing in Las Vegas, Nevada.

I am <u>not</u> affiliated with any specific "group", "cause" or "ISM" whatsoever, and my public commentary represents my <u>individual opinion only</u>. Therefore, I speak in my personal interest and behalf, as well as supportive of the national interest, within the broader scope of the interest of the universe, expressly including all current and successive generations of mankind, (many of whom, understandably, cannot attend today's meeting), hence cannot provide interested recommendations in guidance of the formulation of policies and procedures which will undoubtedly affect their, as yet to be occasioned lives. I hasten to indicate that I am entirely supportive of the non-exclusive application of nuclear power in the national interest, as well as in the genuine best interest of all mankind; said applications including but not limited to both national and international security, power generation, scientific research and other rational usages, and expressly inclusive of methods guaranteeing the ensured effective, responsible storage of hazardous nuclear waste.

However, in view of the profound responsibility which mandates on the basis of <u>reason</u>, that this joint agencies hearing, and all similarly well-intended hearings and resultant policies and procedures, shall serve the genuine best public interest, nationally, internationally, universally and for all of human time, I respectfully submit that the <u>crux issue</u> is neither nuclear energy nor the specifics of storage of nuclear waste, but rather the general and specific context of <u>Human Nature</u>, as it relates to, and indeed profoundly impacts, each and both of those valid interests and concerns.

Therefore, in the interest of time, I hereby respectfully submit the following <u>candid summary of conclusions and recommendations</u>, solely and expressly intended as unistive to the <u>Consensual Reasoning</u> process, and duly considerate of the spectrum of hereto pertinent jurisdictions and sensibilities, beginning with three (3) pertinent observations:

A.

1. The road to hell is paved with "good intentions" which, if exercised devoid of <u>reason</u> and <u>responsibility</u>, are ensured both profligate and failure-inherent;

2. "Truth" is not "the truth" until and unless it is told, in a forthright manner and in its entirety; and:

3. "None of us is "smarter" than all of us combined, which addresses the immediate and compelling need for a national, and indeed global, consensus of opinion directive of the formulation of public policies and procedures pursuant to nuclear concerns which impact the public interest currently and in projection.

Consequently, it is reasonable to responsibly review the following assumptions:

B.

1. The Federal Energy Policy Act (EPA) of 1982 [sic] is fundamentally flawed in terms of its limited scope, depth and intensity and inasmuch as it comprises a publicly-funded, but demonstrably public-excluded, document conceived and implemented predominantly in service to limited special interests of both governmental and pertinent private sector context, rather than predominantly in service to, but indeed adversely impacting, the general public interest, as hereinabove defined.

2. As exemplified, e.g., by the deliberate limiting of today's meeting agenda to discussion of the specific mandate of Section 803 of the Act, it is both irrational and irresponsible, as well as unjustifiable and therefore impossible, to expeditiously "departmentalize", "insimilarize" or otherwise "sever" Section 803 from the entire history of nuclear energy and policy to date, particularly since the concerns and provisions articulated in 803 are the direct consequence, or "spawn", if you will, of that federally-initiated Act, policy and procedure, including subsequent Amendment.

3. Regarding "803's" inferred or implied purpose pursuant to the responsible presentation of public health and safety, it is duly noted and widely recognized that neither the federal government, nor the NRC, nor DOE, nor any other public agencies or private entities of pertinent record, has, or necessarily ever will, admit to any extent of conclusive culpability for any nuclear-pertinent adverse impact upon the health, safety, or life of any persons whatsoever, public or private.

Conversely, and ironically, the Act provides for certain "reasonably found acceptable" levels, or "thresholds" of risk, which inherently (and conclusively) implies that the entire process, inclusive of applied nuclear energy and nuclear waste transport and storage, is indeed hazardous to public health and safety, as is readily attested to by the survivors of Hiroshima and Nagasaki, the former residents of the annihilated Eniwetoc Atoll, the persons characterized as "down-winders", and the first-hand experiences of military observers, scientists and other persons proximally exposed to the awesome effects of nuclear energy and radiation.

As it occurs, nuclear energy and radiation exhibit no national allegiance, makes no distinction between organic life forms or inorganic matter and energy, is indeed of universal impact, and is relatively "immortal" in comparison to the limits of an average human life-span.

4. Thus, whereas certain "eminent alladins" of mankind have "ingeniously" released the nuclear "Genii" from its natural "bottle", .. without bothering to pre-conceive and implement any conclusively guaranteed effective means to either nullify its consequences, or "re-insert" it into the "bottle",.. the hereto pertinent joint agencies of valid jurisdiction, interest and concern, are diligently engaged in devising the most expedient means of "sweeping" the whole thing "under a convenient rug", or "mountain", or other potentially expedient "repositories," and are shamelessly enticing a genuinely under-informed and thereas relatively unsophisticated public to not only "assist" them in that effort, but to pay for it, as well! Significantly, the express purpose of today's meeting is to discuss the possible expansion of the volume and the base of categories of storage - appropriate nuclear waste from future power plants and other nuclear activities.

5. In addition, the Agencies of Record have studiously avoided any pointed reference to and in-depth public discussion of certain significantly relevant aspects of nuclear waste storage, including but not limited to, e.g.:

   (a) The specific means of conclusively guaranteeing any surface or sub-surface-sited nuclear waste repository as impervious to the hazardous impacts of earthquakes, plate tectonics, chemical reactions, or water seepage and/or redeployment, either up, down, sideways or otherwise, but apparently prefer to "departmentalize" and "sever" these pertinent issues, for the sake of expediency; and;

   (b) The Agencies provide no references to, and make no effort to publicly review, e.g., the well-documented merits of, e.g., (1) sub-surface waste deployment in the deep Arctic Ocean; and; (2) the obvious merits, economic feasibility and safety attainable via the secure atmospheric transport of nuclear waste, and the permanent storage of nuclear waste in ground-tethered, atmospherically suspended repositories geodisically secure from and impervious to any and all catastrophic potentials, including atmospheric storms and terrorist attacks, earthquakes and territorial plate tectonics.

6. Stated in least complexity, the <u>crux issue</u> of today's meeting, and all similarly concerned meetings, condenses into the single overriding issue of valid public jurisdiction, intent and concern, based on the glaringly self-evident perception that:

(A) The Federal Energy Policy Act, processes and procedures, including but not limited to the herein public meeting, is the conjoined effort of the government and certain private sector elements to predominantly secure limited special interests, at the public expense and assumption of risk, via the virtual exclusion of and adverse impact upon the general public interest, both nationally, and worldwide, and for the foreseeable future.

7. Therefore, I hereby respectfully recommend that the President and Congress of the United States of America immediately and summarily either:

(A) Provide massive fundamental reform of the EP Act and its pertinent procedures; or;

(B) Terminate and disbain the Act and all thereto pertinent agencies and meetings, in perpetuity; and/or alternatively;

(C) Conceive and implement a coherent and fully integrated process for the development of an omni-participant broad-based <u>public consensus</u>, nationally and globally, pursuant to the rational and responsible formulation and implementation of a universal policy and procedure for the applications of nuclear energy and the effective nullification, or guaranteed secure storage, of nuclear waste products, in the genuine best interest of all mankind and universe, inclusively deemed the creations of, and properly respectful of, the Supreme Being.

<u>In final summary</u>: and in my individual opinion, <u>There is no other ensured effective, national alternative!</u>

Thank you for the opportunity to address this public meeting.

Supportive of the worthwhile purpose of the meeting, I wish you "Godspeed", and appropriate "Good Luck," in the conceivability that you may welcome, and indeed require, <u>Both</u>.

Respectfully Submitted,

Tom McGowan
Public Citizen

NATIONAL TAXPAYERS UNION

August 19, 1993

Mr Dwight E. Shelor
Office of Civilian Radioactive Waste
Management
U.S. Department of Energy
1000 Independence Ave. S.W.
Washington, D.C. 20585

Dear Mr. Shelor:

Enclosed are our comments on the Advanced Liquid Metal Reactor thatwas discussed in Chapter Five of the 1993 Draft Report on the Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High Level Radioactive Waste.

Sincerely,

Jill Lancelot

Jill Lancelot, Director
Congressional Affairs

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NATIONAL TAXPAYERS UNION

Comments by Jill Lancelot, Director of Congressional Affairs, National Taxpayers Union on the June 1993 Draft Report:
"Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste
A Report to the President and the Congress
in Accordance with Section 803 of the
Energy Policy Act of 1992"

The National Taxpayers Union appreciates the opportunity to submit comments on the June 1993 Draft Report as set forth in Section 803 of the National Energy Policy Act of 1992. Our comments will be directed to Section 5, Partitioning and Transmutation Case for Spent Nuclear Fuel and High-Level Radioactive Waste, in particular regarding our concerns of employing advanced liquid metal reactor (ALMR) technology to dispose of high-level nuclear waste.

In 1983, the Congress voted to terminate the Clinch River Breeder Reactor on the grounds that liquid metal breeder reactors are not economically competitive and have little potential commercial application as well as posing serious environmental, safety and proliferation risks. The ALMR poses many of the same problems.

Periodically the breeder program gets repackaged to appeal to the perceived national need of the moment. Recognizing that breeder technology for electricity generation lacks economic justification and that it lacks commercial interest, proponents of the technology now tout it as a mechanism for nuclear waste disposal. Trying to attract widespread appeal, the liquid metal reactor (LMR) program is now being called the "actinide recycling" program. Regardless, of whether or not it has a uranium blanket or whether or not it produce more fuel than it consumes, these changes of name or modification of function do not eliminate the fact that the technology is still liquid metal breeder technology which was rejected largely because it was just too costly.

The ALMR program is simply an effort to revive a rejected technology. The technology is in search of a function. In the 1970's when the nuclear industry claimed there would be 1000 nuclear power plants on line in the year 2000, there was fear that uranium would be scarce and expensive. Thus, breeder reactors were seen as the means of extending uranium resources. When electricity demand projections for uranium dramatically declined, breeders were clearly unneeded and not at all cost-effective.

Since that application became obsolete the scientists came up with a new task -- fissioning nuclear waste. As concerns about the long term disposal of nuclear waste became a problem, ALMR technology was promoted as an electricity generating technology that could "recycle actinides" from light water reactors as well as fission nuclear waste from dismantled warheads.

However, in the National Research Council's Interim Report of the Panel on Separations Technology and Transmutation Systems, the participants, including ALMR project participants, "felt it made no sense to develop and deploy ALMRs solely for actinide burning. The breeder will be introduced when public policy, licensing, and economic considerations, such as the cost and availability of uranium, justify it." To be economically viable uranium would have to be about $165 a pound instead of the current price of approximately $10 a pound. It is highly improbable that current uranium prices will rise in the future, given the fact that demand for uranium has been stagnant while supply continues to increase. This uranium glut has resulted in part from Highly Enriched Uranium (HEU) inventory increases associated with military operations.

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Moreover, it is clear that the ALMR's role for Partitioning and Transmuting (P-T) nuclear waste is not economically viable either. During the 1970's the U.S. and other countries evaluated the options for the disposal of high-level radioactive wastes (HLW). The worldwide scientific community decided that the most feasible option was deep geologic disposal. Indeed, they ranked P-T as among the least favored options. In fact, the International Atomic Energy Agency said that the key reason for this ranking was, "Since the long-term hazards are already low, there is little incentive to reduce them further by P-T. Indeed **the incremental costs** of introducing P-T **appear to be unduly high** in relation to the prospective benefits."

Studies done in 1980 by A.G. Croff, et al from Oak Ridge National Laboratory said there were "no cost or safety incentives for P-T of the actinides for waste management purposes." In February of 1992 Lawrence D. Ramspott et al from Lawrence Livermore National Laboratory in an independent study concluded that little has changed that would alter the earlier conclusion. The study stated, "There remains no cost or safety incentives to introduce P-T into the HLW management system....The economics of other options for producing electrical power, including nuclear, are far more favorable than P-T and will remain so for the foreseeable future. The study went on to say, "The fundamental reason for the rejection of P-T as a viable waste management option in the early 1980's was its economics...the relative economic position of LMRs and LWRs has not changed much over the past decade."

There is no justification for spending scarce dollars on programs that probably won't be needed at all, or to be conservative, not for at least 50 years. But in a curious evolutionary twist, today's "cutting edge" technology could become tomorrow's dinosaur. The face of energy generation technology 50 years from now might bear little or no resemblance to any of the technologies being developed today supposedly for future use. In fact, developing a technology before it is economically justified guarantees wasted resources on a venture that could very well be rendered obsolete.

To have any real effect on waste disposal, an incredibly enormous and therefore incredibly costly complex would have to be built. In addition to the 19 large liquid metal reactors, two or more reprocessing plants, new fuel fabrication facilities, a fuel extraction plant and perhaps a new long-term surface storage and waste-handling facilities would have to be constructed. The costs at this time are unquantifiable but certain to be enormous.

The reprocessing technology associated with ALMR rests on extremely shaky scientific grounds. In fact, the tarnished past of conventional reprocessing methods only reinforces the fiscal concerns of ALMR opponents. Experience with recent foreign construction of fuel reprocessing indicates continued uncertainty in the cost of conventional reprocessing.

Future reprocessing technologies of the ALMR could therefore represent a technological leap of faith into a fiscal quagmire. If conventional reprocessing methods with more familiar technologies could dramatically understate end-cycle costs, one shudders at the possible expense that may be incurred with, as nuclear engineering professor Thomas H. Pigsford says, "separations that have not been proved, have not been performed on an industrial scale, and have not been subjected to licensing."

According to the Ramspott, et al. 1992 report, "P-T would greatly increase economically the net cost of the overall nuclear energy system." The report estimates that reprocessing the existing LMR fuel would add more than $84 billion, which is nearly quadrupling the current estimate of $33 billion for geologic disposal.

If this technology is so promising then it should attract private sector financing. Except for a mere $2 million from one utility, private industry has been unwilling to share costs for this venture. It is unlikely that the situation will change. As Edward Davis, President of the American Nuclear Energy Council, testifying before the Energy Subcommittee of the House Science, Space and Technology Committee recently stated, "...it does suggest that utilities have made the decision to proceed first with the Advanced Light Water Reactors (ALWRs). They believe the ALWR is the nuclear energy option that must take top priority in both industry and the federal programs in the near future. He went on to say, "The industry's initial look at the economic questions resulted in a preliminary determination that the transuranic burning process, while promising, is unlikely to be cost-effective for the fuel currently stored in spent fuel pools around the country today. ...To be clear, however we see no benefit in considering transuranic burning as a waste solution for current fuel."

According to the Ramspott report, "Utilities have no incentive to adopt any form of P-T now or in the near future because of its high costs. P-T can only be considered as a government-financed option. It appears that there is little commercial interest in the technology.

The ALMR could also generate a number of unintended but potentially disasterous fiscal problems. Since breeder reactors could provide a major source of plutonium, the threat is ever present of bomb manufacture from nations who may gain access to plutonium if the U.S. promotes this technology. The budget consequences of increased U.S. defense spending that would be required to counter this threat are likewise frightening.

Proponents will frame ALMR's waste burning potential as a self-less gift to grateful present and future generations. Unfortunately, those generations will have to wait a long time to receive their so-called gift. The Livermore study concluded, "It will take at least 1,000 years of fuel-reprocessing and transuranic recycling to achieve an overall transuranic inventory reduction factor of 100, only 10% of the level specified by the ALMR program.

The market does not lack for economically attractive, low risk options, and there is absolutely no justification for singling out the ALMR technology to fulfull some artificially fabricated need. In a market-oriented economy, limited resources almost always gravitate towards their most productive and efficient use. Once the federal government intervenes in this process, however, false economies usually result, much to the detriment of taxpayers Bad economic decisions resulting from government subsidies also become commonplace and are rarely reversible. In the final analysis, few if any federal programs can imitate the rigors of the marketplace, or withstand the sensible economic tests the marketplace provides. ALMRs will result in an expensive energy grid, which will undermine the ability of businesses to secure credit for expansion and generate new jobs, and will dramatically lower the standard of living for our children. This is precisely the future our nation may confront unless federal spending is brought under control and not forced to continue its deficit spending with expensive and unneeded programs such as the ALMR.

August 1993

BOB MILLER
Governor

STATE OF NEVADA

ROBERT R. LOUX
Executive Director

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August 20, 1993

Mr. Dwight E. Shelor
Office of Civilian Radioactive
Waste Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

Re: State of Nevada's Final Comments -- Section 803 Report, Energy Policy Act of 1992

Dear Mr. Shelor:

The State of Nevada appreciates the opportunity to provide final comments on the report required under Section 803 of the Energy Policy Act of 1992. As you know, Section 803 directs the Department of Energy (DOE) to prepare a congressional report that assesses the adequacy of existing DOE plans and programs to manage nuclear waste generated by nuclear power plants to be constructed after 1992. The law also requires the analysis to include defense waste that might be generated from future reprocessing and cleanup of the DOE's nuclear weapons manufacturing plants.

As stated in the Federal Register Notice dated February 5, 1993, the DOE's Office of Civilian Radioactive Waste Management (OCRWM) must submit this report to the President and the Congress by October 1993.

In April 1993, the State of Nevada provided extensive "scoping" comments on a draft annotated outline for the report[1]. After reviewing the draft report, including the DOE's response to our comments, we subsequently delivered a detailed public statement[2] on the draft report at the DOE sponsored public meeting held in Las Vegas, Nevada on July 20, 1993.

Below is a summary of our final comments followed by an attachment with a more detailed review. These final comments are based on a thorough review of the draft report, a review of DOE's responses to comments provided on the annotated outline and our assessment of other comments provided at the public meeting held in Las Vegas, Nevada.

Once again, these are our last and final comments on the congressional required Section 803 report and we are requesting that these final comments, along with the DOE's responses, be included in the final report that will be submitted to the Congress.

COMMENT SUMMARY

- Each case scenario described in the draft report should be amended to include all "other wastes" described in chapter 7 of the draft report. "Other Wastes" include high-level waste (HLW) generated from the Decontamination and Decommissioning (D&D) of nuclear power plants and defense waste facilities, wastes classified as Greater-Than-Class C (GTCCW), and all DOE owned spent fuel. All of these wastes are slated for disposal in a geologic repository. In addition, the uncertainties concerning the amount of defense waste, in terms of the number of waste canisters that might be produced from the DOE's vitrification program, should be quantified in the final report.

- The final report should address the issue of repository capacity. Without addressing the issue of total waste capacity for a single repository, the DOE simply cannot draw any convincing conclusions about the adequacy of existing plans and programs to deal with the storage and disposal of wastes to be generated in the future. The issue is further complicated by the DOE's inability or unwillingness to investigate any waste management contingencies should the Yucca Mountain site be found to be unsuitable. Finally, because the draft report fails to estimate the waste capacity of the Yucca Mountain site, the DOE cannot assume that an additional repository will not be needed in the near term.

• Critical questions about the schedules and costs of the repository program are not dealt with in the draft report in a meaningful way. Recent findings by the U.S. General Accounting Office (GAO) point to serious cost shortfalls that have significantly altered the legally required milestone for acceptance of waste by the DOE. Accordingly, the final report should assume that interim dry cask storage of commercial spent fuel at reactor sites will be the most likely scenario for waste management in the near term. Hence, the "case scenarios" presented in the report should include this assumption as the basis for the evaluation of the adequacy of the current plans and programs to manage both existing wastes and future wastes from new nuclear power plants.

• The Secretary of Energy's 1993 planned review of the DOE's repository program is based on the notion that the DOE has yet to demonstrate that it can successfully site, characterize, or develop a HLW management facility. Accordingly, the final report should address whether the DOE's current program is in fact adequate to carry out plans and programs for managing waste inventories at both the reference case (base case) and future waste generation levels.

• Because the draft report failed to provide a cost analysis for the upper bound scenario (i.e. Partitioning and Transmutation), this scenario should not be included in the final report. The upper bound scenario should also be omitted because the purpose of the report has nothing to do with future energy demand or the potential "acceptability of nuclear power". We contend that it is not the DOE's mission or responsibility to market this unproven technology on behalf of the nuclear power industry. Nevertheless, in the "likely" event that the DOE retains this scenario, then the DOE must acknowledge the licensing difficulties that will result from co-mingling of canisters containing spent fuel from light water reactors and canisters containing corrosive wastes from pyro-chemical reprocessing.

• Despite the intent of Congress in mandating this report, the DOE has developed a report, which simply finds that present plans and programs are adequate to manage the disposal of spent fuel generated by nuclear reactors constructed after 1992. The notion of flexibility, however, which is the key to the DOE's finding of adequacy (as stated in the draft report), is largely the flexibility to amend the Act, which the DOE has so successfully promoted at critical times over the past several years.

Sincerely,

Robert R. Loux
Executive Director

Attachment
RRL/jbw

cc: Governor Bob Miller
Nevada Congressional Delegation
Leo Penne, State of Nevada, Washington Office
U.S. Nuclear Regulatory Commission
U.S. Environmental Protection Agency
Affected Local Governments

STATE OF NEVADA'S FINAL COMMENTS
SECTION 803 REPORT, ENERGY POLICY ACT OF 1992
August 20, 1993

I. WASTE VOLUMES

The report discusses three scenarios concerning the amount of high-level waste (HLW) and spent fuel that will be produced by existing nuclear power plants, future nuclear power plants, and defense waste processing facilities.

Although most assumptions for the scenario appear reasonable, none of the three scenarios includes estimates of "other wastes" that are slated for geological disposal. The report also failed to include reliable estimates of HLW generated from DOE defense reprocessing activities.

Other Wastes: Other wastes are defined as DOE owned or managed spent nuclear fuels (such as low burn-up spent fuel previously scheduled for reprocessing and naval reactor fuel), wastes classified as greater than Class "C", and waste from decontamination and decommissioning activities. By excluding "Other Wastes" from the three scenarios, the report fails to fully assess the adequacy of existing plans and programs for the management of wastes generated at current or future projected levels. As an example, the DOE's own inventory of spent nuclear fuel would increase current fuels in storage by as much as 13 percent[3].

High-Level Waste (HLW): The ultimate volume of HLW that might be produced for deep geologic disposal is not adequately discussed in the draft report[4]. This determination is essential to assess the impact of HLW disposal on existing DOE plans, facility designs, as well as on the need for additional repositories. Specifically, the draft report fails to discuss reasons for the large disparity in the number of HLW canisters that will be produced. As the DOE is well aware, most of the uncertainty surrounding the discrepancy in the number of canisters stems from the "stalled" vitrification program at the Hanford site. The report should make note that the DOE's Environmental Restoration and Waste Management Program (EM) is currently conducting a "re-baselining study" to determine alternatives for the management, treatment, and disposal of the HLW at Hanford. The report should also acknowledge that recent changes in the EM program at Hanford have been undertaken to address safety concerns associated with HLW tank storage, as well as with the uncertainties concerning waste pretreatment systems. At a minimum then, the final report should address the HLW volume issue and its potential impact on the amount of waste that can be disposed in the first repository (i.e., 70,000 Metric Tons of Heavy Metal MTHM).

II. ISSUES THE REPORT SHOULD ADDRESS

The development of conclusions and recommendation about managing future wastes must be based on a clear understanding of DOE's current plans and programs to manage radioactive wastes generated by existing nuclear power plants and defense waste processing facilities. We believe this was the intent of Section 803 of the Energy Policy Act. Yet the draft report fails to address this concern at the most rudimentary level.

By the DOE's own admission, the draft report limits the analysis of existing programs and plans to "programmatic" concerns, while excluding important technical issues. We contend, however, that there are certain technical issues that must be understood to forecast the adequacy of DOE's existing and future waste management programs. Examples of these technical issues include:

- Repository Waste Emplacement Capacity;
- Statutorily Required Schedules and Program Costs;
- Program Management and Systems Integration;
- Contingencies;
- Regulatory Constraints.

These are issues the report must focus on if the DOE is sincerely interested in assessing the flexibility and adequacy of its current plans and programs to manage future wastes from power plants constructed after 1992.

• **<u>Repository Waste Emplacement Capacity</u>:** We contend that by not estimating this parameter, the DOE will miss the intent of Section 803 of the Act. Clearly, the requirements of the Energy Policy Act suggest that Congress wants to know what the available waste emplacement capacity of the Yucca Mountain site or a generic repository site might be. Such an estimate is critical for determining the adequacy of existing plans and programs to handle future waste generation.

To estimate the waste emplacement capacity of a repository, the DOE should develop a common unit of measure[5] for the different types of wastes, which includes "Other Wastes" as described in Section 7 of the draft report. A common unit of measure is needed for the estimation of the areal power density, which can then be used to estimate the space needed for waste emplacement. Such an analysis does not involve geologic or hydrologic data and actually is a "programmatic" concern.

• **Statutorily Required Schedules and Program Costs**: Section 302 of the Nuclear Waste Policy Act as amended, stipulates that the Secretary of Energy will begin accepting nuclear waste for disposal by January, 1998. Because the DOE has not changed this date in budgeting forecasts and in discussing contractual obligations with utilities, this "statutorily required scheduled" must be discussed in the final report. Specifically, the report should state that a decision for a repository site will not be finalized by 1998 and that it is highly unlikely that a Monitored Retrievable Storage Facility (MRS) will be available at this early date as well. These are important concerns since the overall program cost remains an issue for ratepayers, the Congress, and the President. Rather than basing program assumptions on the existence of an MRS by 1998, all scenarios in the final report should be based on the assumption of interim dry cask storage for spent fuel at existing nuclear reactor sites. This is the most likely scenario for the reference case and the final report should adopt this assumption for evaluating the adequacy of existing plans and programs to manage both current and future waste generation.

If the final report evades such an assumption, then the DOE must conclude that its current plans and programs are inadequate to handle existing waste management activities as stipulated under the time periods required in current legislation. Along this same line, and because of the uncertainties surrounding the volume and number of HLW canisters and "Other Wastes", the final report should also assess the requirement to advise the President and the Congress on the need for a second repository[6].

• **Program Management and Systems Integration**: Recently, the Nuclear Waste Technical Review Board (NWTRB) advised the Congress that the DOE is experiencing significant management problem(s) that are affecting certain technical aspects of the repository program[7]. According to the NWTRB, organizational management at the DOE is a significant problem and is contributing to inefficiencies, particularly in the development of an integrated waste management system. They found the organizational structure of the program is multilayered and spread out over a wide geographic area, with highly fragmented decision making being shared between DOE personnel, the management and operations (M&O) contractor, other private contractors, the national laboratories, and the U.S. Geological Survey[8].

Given these highly critical remarks, the final report should present conclusions and recommendations about the adequacy of the DOE's institutional, organizational, and management abilities that will be needed to carry out the plans and the programs for managing current and future waste inventories. Furthermore, because so many uncertainties plague the DOE's existing repository program and because management decisions are diffused and uncoordinated, we contend that the program remains in a permanent state of transition.

While the draft report claims that the DOE's current waste management program is flexible and adequate to manage future waste from new nuclear power plants, the facts presented in the draft report do not support this finding. The DOE has yet to demonstrate that its waste management program is in compliance with key requirements of the Nuclear Waste Policy Act as amended. The DOE has failed to write a comprehensive update to the Mission Plan, as required by the Act. This has left the Congress and the people of Nevada without a concise up-to-date description of the program. Hence, without a Mission Plan, without a credible Site Characterization Plan, and without regulatory standards to guide site characterization at Yucca Mountain, we think that the DOE cannot make a determination on the adequacy of its existing program.

The DOE's repository program simply lacks the management structure to implement a fully integrated waste management system. The final report should reflect this situation rather than postulate that the program is adequate and flexible to manage existing and future wastes generated by the commercial power industry and DOE defense activities.

• **Program Contingencies**: The draft report makes the following statement: "Major facilities for storage, transportation, and disposal have not been sited, and final designs for their construction have not been developed ... therefore, the system design can be adjusted to meet new requirements." The present plan calls for the Yucca Mountain site to be the first repository. There are no backup sites under consideration, nor are there any contingencies under contemplation. Thus, should there be a need to abandon the Yucca Mountain site, the system cannot "be adjusted to meet new requirements."

In addition, the draft report asserts that the disposal capacity of the first repository is now an objective of site characterization, which is simply not the case. The objective of the Yucca Mountain Site Characterization Plan clearly indicates that the site is being characterized for 62,000 MTHM of spent fuel and the equivalent of 8,000 MTHM of defense high-level waste. Even if the Congress were to decide to adjust the waste cap, stipulated under the Nuclear Waste Policy Act (i.e. 70,000 MTHM), because the draft report failed to estimate the waste emplacement capacity of Yucca Mountain, means that DOE cannot assume that additional repositories will not be needed in the near term.

• **Regulatory Constraints**: Section 801 of the Energy Policy Act of 1992 requires the Environmental Protection agency (EPA) to promulgate new health-based dose standards to protect the public from the release of radioactive materials at the Yucca Mountain site. The law further requires the EPA to contract with the National Academy of Sciences for the recommendation of the new standards. The law then compels the Nuclear Regulatory Commission (NRC) to conform its regulatory requirements and criteria to the new EPA standards.

While the draft report ignores issues pertaining to regulatory compliance, the final report should acknowledge that it is likely that new dose rates and new release standards will emerge from revisions to existing regulatory strategies contained in 40 CFR 191. The report should also acknowledge that when regulatory problems have been encountered in the past, the DOE has simply lobbied the Congress to rescind the obstacle concerning regulatory compliance.

We note for example, a 1992 document issued by a DOE Contractor[9], which concludes that release of gaseous Carbon-14 from a repository at Yucca Mountain was problematic and that solving the issue could be accomplished only by continuing to "interact with the EPA" concerning revisions to 40 CFR Part 191, including the containment requirements for Carbon-14. Carbon-14 is a problem for repository sites, such as Yucca Mountain located in the unsaturated zone. Congressional action implementing Section 801 of the Energy Policy Act was the result of the Carbon-14 controversy, which suggests that when the DOE encounters problems pertaining to regulatory requirements, the notion of flexibility implies correction of the problem at the legislative level rather than at the programmatic or technical level. Accordingly, the notion of flexibility, which is the key to DOE's finding of adequacy in the draft report implies flexibility to amend the Act, which the DOE has so successfully promoted for the past several years.

III. ISSUES THE REPORT SHOULD NOT ASSESS

It appears that the main thrust of the draft report is to encourage congressional support for a new spent fuel reprocessing technology along with an un-proven, yet to be demonstrated, liquid metal actinide burning reactor concept. The report calls this the "Partitioning and Transmutation Case for Spent Nuclear Fuel and High-Level Radioactive Waste."

We contend that this section of the draft report should be completely eliminated. Reprocessing commercial spent fuel through the use of a pyro-chemical reprocessing method to produce fuel elements for an actinide burning reactor is an unproven technology, which may require decades of development. Moreover, if the DOE remains intent on "marketing" this technology, then the final report should at least assess the associated research and development costs for establishing new reprocessing plants, fuel fabrication facilities, and liquid metal reactors.

Instead of projecting associated costs for these technologies, or addressing the difficulties inherent in co-mingling canisters containing spent fuel and canisters containing corrosive salts in a single repository, the draft report only focuses on the wide margin of uncertainty about the waste volumes that would be generated by the unproven technology. On the issues of co-mingling, we are aware that scientists from the DOE's Argonne National Laboratory[10] have suggested that co-mingling pyro-process waste with spent fuel from light water reactors would likely complicate the licensing process for the first repository. As might be expected, however, the anticipated problems associated with co-mingling of different waste types in a single repository were not addressed in the draft report.

ENDNOTES

[1] Comments by the State of Nevada, Section 803 -- Energy Policy Act of 1992, April 6, 1993. Agency for Nuclear Projects, Nuclear Waste Project Office.

[2] Statement by the Agency for Nuclear Projects, Nuclear Waste Project Office to the U.S. Department of Energy on a draft congressionally required report titled " Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste (Draft for Public Comment)." The statement was given at a public meeting held in Las Vegas on July 20, 1993.

[3] U.S. Department of Energy, Spent Fuel Background Report, Predecisional Draft, June 25, 1993 (Page 3-2).

[4] The variation in the number of HLW canisters that might be produced for final disposal in a federal repository range between between 15,000 and 21,000 -- to more than 200,000. See Sixth Report to the U.S. Congress and The U.S. Secretary of Energy, Nuclear Waste Technical Review Board, December 1992, page 24.

[5] In comments submitted on DOE's annotated outline for the Section 803 report, the Nuclear Regulatory Commission suggested that "in order to determine repository capacity needs in the future, it will be necessary to establish some common unite of measure for these different waste types", (i.e., waste materials form boiling-water and pressurized-water reactors, D&D waste and HLW from defense installations such as glass logs and solidified sludges).

[6] Amendment to the Nuclear Waste Policy Act (Title V of P.L. 100-2003, section 161(b)).

[7] NWTRB, Special Report to the Congress and the Secretary of Energy, Nuclear Waste Technical Review Board, March 1993, page 14.

[8] Only 12 percent of the 2,000 people working on OCRWM's repository program are DOE employees, the rest are considered agency contractors.

[9] Yucca Mountain Site Characterization Project, Report of Early Site Suitability Evaluation of the Potential Repository Site at Yucca Mountain, Nevada, January 1992. Science Applications International Corporation, SAIC-91/8000.

[10] Use of Transuranic elements form LWR Fuel in Integral Fact Reactors, Report ANL-IFR-165, Johnson T.R., L. Burrios, N.M. Levitz and R. N. Hill, February 1990.

STATEMENT TO
THE U.S. DEPARTMENT OF ENERGY

ON A DRAFT CONGRESSIONALLY REQUIRED REPORT TITLED

"Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste"

July 20, 1993 at Las Vegas, Nevada

OPENING REMARKS:

The State of Nevada, Agency for Nuclear Projects appreciates your invitation to make a presentation on the draft report titled "Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-level Radioactive Waste".

Our statement today is intended to provide an overview of our concerns with the report and we will submit formal written comments as per the Federal Register Notice dated Monday, June 21, 1993.

As you know, the State of Nevada was one of only four entities that provided detailed comments on the annotated outline for this Congressionally-required report. In those comments, we suggested that the Department of Energy (DOE) should provide a discussion concerning the adequacy of its <u>current</u> plans and programs to handle radioactive waste generated by existing nuclear power plants.

We made these comments in the hope that DOE would begin by assessing the adequacy of its existing waste management program, as the first step, in developing a more comprehensive approach to a fully integrated waste management system including defense wastes and waste from any new power plants constructed after 1992. Indeed, we believe this was the intent of section 803 of the Energy Policy Act of 1992, which required that DOE submit this report.

However, in reviewing the draft report, it is clear that DOE has adopted its own interpretation, contrary to the intent of this legislation.

The Draft report claims that DOE's current waste management programs are flexible and therefore adequate to manage future waste from new nuclear power plants. The facts do not support this finding.

<u>First</u>, DOE has yet to demonstrate that its waste management program is in compliance with a key requirements of the Nuclear Waste Policy Act of 1982, as amended. The DOE has not published a comprehensive Mission Plan, as required by the Act, since prior to the substantial changes enacted in the 1987 amendment to the Act. This has left Congress, the public, and the people of Nevada without a concise up-to-date description of the program. Specifically, the Mission

Plan must provide "an informational basis sufficient to permit informed decision to be made in carrying out the repository program ..." (Sec. 301[a]). Without an up-to-date final Mission Plan, we are left only to guess how the Department intends to implement the requirements of the Act. Nevertheless, the draft report reaches the conclusion that current programs and plans are flexible and adequate to handle future waste generation.

Second, because DOE's program for conducting scientific investigations at Yucca Mountain is constantly in flux, claims of its adequacy are suspect and unfounded.

Third, because DOE's repository characterization program is now functioning without any environmental regulatory standards for the management and disposal of spent fuel and high-level radioactive waste, activities are being conducted without due consideration of what level of radionuclide releases may be determined acceptable in the future. Nevertheless, in the draft report DOE has made the finding that the existing program is flexible and adequate for managing future waste from new power plants.

Fourth, in response to our comments on the annotated outline, we found that DOE now admits that there are formidable challenges regarding the ability of the

Department to manage radioactive waste generated by existing nuclear power plants. We also note that DOE believes that Congress is fully aware of the "challenges" facing the program.

To address these challenges, the Secretary of Energy has acknowledged the need for a full scale review of "all aspects of the program." Given this commitment and the endless list of uncertainties that beleaguer the current program, we find it remarkable that DOE can make the finding that the program is flexible and adequate to manage waste from new power plants.

Section 803 of the Energy Policy Act requires DOE to assess the adequacy of current programs and plans mandated by the Act. Without a Mission Plan, without a credible Site Characterization Plan, and without regulatory standards to guide site characterization at the Yucca Mountain site, we think DOE simply cannot make a determination on the adequacy of its existing program.

On the contrary, what this report seems to confirm, is that DOE has either failed to follow, has changed, or has altogether disregarded the programmatic requirements contained in the Nuclear Waste Policy Act, as amended.

OTHER ISSUES:

Now let me turn to a discussion of other issues that should be incorporated into the final report. On page 6-6 of the report a statement is made about how the analysis in the report was conducted at the "programmatic" level, rather than at a detailed technical level. Specifically, the report states that:

> "Technical aspects of the program such as waste emplacement capacities and schedules, facility designs, and facility cost estimates did not need to be evaluated to reach conclusions that satisfy the purpose of this report".

At a minimum, we must disagree that schedules, repository waste emplacement capacities and costs are nothing more than "technical aspects of the program".

The Waste Acceptance Schedule, for example, is a statutory requirement under Section 302 of the Nuclear Waste Policy Act. The statute requires the Secretary to begin waste acceptance for disposal by January, 1998. Because DOE has relied heavily on this date for budgeting and for contractual obligations, we believe it is a "programmatic" milestone and not just a "technical aspect" of the program. We note, however, that nowhere in the text of the report is the 1998 deadline discussed.

In reference to Repository Waste Emplacement Capacities, we contend that, by not estimating this factor, DOE has missed the intent of the report. Clearly, the requirements of the Energy Policy Act, suggest that Congress wants to know what the available waste emplacement capacity at the Yucca Mountain site might be. Such an estimate is critical for determining the adequacy of existing programs and plans to handle future waste generation, should Yucca Mountain be developed as a repository.

To estimate the waste emplacement capacity for a single repository, DOE should develop a common unit of measure for all the different waste types including those wastes described in Section 7 of the report. This was the recommendation made by the Nuclear Regulatory Commission in comments submitted for the annotated outline, yet DOE simply ignored this comment. Without this analysis, DOE can not reliably determine existing or future repository waste emplacement capacities.

Cost Estimates: For certain major facilities, we believe that from a programmatic standpoint, cost estimates are important. On page A-12 of the draft report, we note the statement -- "Spent nuclear fuel will be shipped from the monitored retrievable storage facility to the repository by rail in dedicated trains, [and] all high-level radioactive waste will be shipped directly by rail from (DOE's defense sites) to the repository."

The cost of providing rail transportation to Yucca Mountain is a major issue that should not be ignored. In fact, according to some estimates, the cost of building a rail line to the site will likely exceed one billion dollars. Again, this is a significant cost item that should not be ignored in assessing capabilities of existing programs and plans to handle future waste from new nuclear power plants.

As we noted in our comments on the annotated outline, developing reliable cost estimates for a disposal program is important for determining the real price that must be paid for nuclear power. Thus, since the intent of the report is to advise the Congress about managing the waste from new nuclear power plants, we contend that the report should assess the cost of management and disposal of wastes generated by power plants constructed after 1992. It should also be noted that the current cost estimating program is not being revised annually as required, and the latest revision discusses cost estimates in 1988 dollars. While these cost estimates may be applicable to scenarios 1 and 2, as presented in the report, there is no cost estimate for scenario 3, which would involve the construction of numerous liquid metal reactors, new fuel reprocessing plants, as well as a more extensive transportation system.

There are at least three other issues that need additional attention in the final report.

The first issue is the Monitored Retrievable Storage Facility (MRS). On page A-5 of the draft report we note the following statement about the MRS siting effort.

> "In 1991, the Nuclear Waste Negotiator began an intensive effort to locate a volunteer host and issued a formal request for expressions of interest [and] more than 21 grant applications have been received and some have been awarded study grants."

Because the MRS concept continues to play a key role in DOE's waste management system, particularly in meeting the waste acceptance deadline of 1998, the report should provide additional information about the status of the MRS siting process, and the current understanding that it is highly unlikely to result in waste acceptance by 1998.

Second, is the issue of Defense Waste. The discussion and analysis concerning the volume of defense waste presented throughout the report is confused, fragmented, and misleading. The report fails, for example, to explain or clarify the status of those wastes held in the single-shell tanks at the Hanford site in Washington state. The report simply states that in the "reference case," 10,000 canisters will be produced while in the "high-generation case", 35,000 canisters will be produced.

Also, given DOE's decision to end reprocessing of all DOE held spent nuclear fuel, the report fails to provide an analysis of the "projected" amount of spent fuel that would ultimately be generated for disposal in a geological repository. This would include fuel from all the research reactors manufactured in the U.S. and currently in operation, Naval reactor fuel, and spent fuel and high level waste produced by the fission disposition of plutonium from dismantled nuclear weapons. These estimates should have been combined with the miscellaneous spent fuel amounts described in Section 7 and included in the estimate for the case scenarios.

Third, is the issue of New Technologies. We recognize that DOE and the nuclear industry are interested in developing a next new generation of nuclear reactors. However, we believe it is inappropriate to use this Congressionally-required report as a forum to advance a new spent fuel reprocessing technology along with the advanced liquid-metal reactor concept. The uncertainties surrounding these technologies are evidenced in the report by the wide margins of nuclear waste that could be produced. We note the report says that "the ranges in these data are because of differences in the assumed reactor design, which has not yet been fully effective for actinide burning."

CONCLUDING REMARKS:

We cannot agree that the present plan for the management of spent fuel and high level radioactive waste is flexible and adequate to handle the waste to be generated in the future. We note the report finds that:

> "major facilities for storage, transportation, and disposal have not been sited, and final designs for their construction have not been developed .. Therefore, the system design can be adjusted to meet new requirements"

This statement is based on the premise that Yucca Mountain is the site of the first repository, which is clearly a presumption on DOE's part. More importantly, there are no backup sites under consideration nor are there any contingencies being considered. Hence, should there be a need to abandon the Yucca Mountain site, the system design cannot "adjust to meet new requirements."

In addition, while the report asserts that the disposal capacity of the first repository is now an objective of site characterization, we firmly disagree that this is the case. The objective of the Yucca Mountain Site Characterization Plan clearly indicates that a potential repository at Yucca Mountain is being strictly designed for 62,000 metric tons of spent fuel and 8,000 equivalent tons of defense high-level waste. Even if

Congress expands the waste cap, the report fails to estimate the waste emplacement capacity for Yucca Mountain, which means that DOE cannot assume that an additional repository will not be needed in the near future.

Since the two upper bound scenarios are based on the assumption that nuclear power will experience significant growth in the near future, the report's conclusion should be that -- if the industry grows, additional repositories will be needed.

We also take exception to the statement in the report that says "the Department has considerable experience with repository siting activities and site characterization." The Secretary's planned review of the program is evidence that this is just not the case, -- as is the fact that DOE has yet to demonstrate that it can successfully site and develop any commercial nuclear waste management facility.

Finally, the report appears to be written primarily to promote DOE's current program and plans at Yucca Mountain, while ignoring major uncertainties and flaws in the program.
Despite the intent of Congress in requiring this report, the DOE has developed instead a report that simply finds the Nuclear Waste policy Act as amended, is an adequate policy statement to guide management and disposal of spent nuclear fuel from reactors development after 1992. The notion of flexibility, which is the

key to DOE's finding of adequacy is largely the flexibility to amend the Act, which DOE has so successfully prompted at critical times during the chaotic 10 year history of the Act.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

AUG 27 1993

Mr. Lake Barrett, Acting Director
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D. C. 20585

Dear Mr. Barrett:

SUBJECT: CONSULTATION WITH THE U.S. DEPARTMENT OF ENERGY CONCERNING SECTION 803 OF THE ENERGY POLICY ACT OF 1992

On July 1, 1993, the Nuclear Regulatory Commission staff received the draft document, "Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste" produced by the Department of Energy (DOE) as mandated by Section 803 of the Energy Policy Act of 1992. The NRC staff committed to the review of this document in my letter to you dated March 15, 1993.

Because the draft report is based mainly on program activities that are the responsibility of DOE, the NRC staff has chosen not to comment on the validity of the cases, scenarios and conclusions reached by DOE as stated in the draft report. However, there are several comments on various aspects of the report that the NRC staff believes DOE should consider. These are detailed in the enclosure, and should be considered together with the broad comments provided below.

In response to the NRC staff's comment (Bernero to Barrett, March 15, 1993) on the need to establish equivalencies for the different types of waste, DOE determined that establishing equivalencies was unnecessary for this report. The NRC staff renews its comment that equivalencies should be established at some time in the program. Therefore, as DOE begins to develop the detailed activities to support its waste management program, it should determine how it will equate the different volumes and thermal loadings for the various waste types.

The draft report sets out other radioactive wastes not assumed in scenarios considered in DOE's report. Specifically, on page 7-5, the draft report states that geologic disposal may be required for radioactive material from the dismantling and decommissioning of the tanks and facilities at which high-level waste is currently stored. It further states that the long-term disposal of highly enriched uranium has not yet been determined. In addition, the NRC staff recommends that DOE consider high-level wastes associated with the disposition of government owned materials to be inventoried as stated in Section 1016 of the Energy Policy Act of 1992. Without including these additional wastes in its evaluation of the waste disposal system, DOE may not be completely analyzing all the waste that will require final disposal in a deep geologic repository.

I trust these comments will be useful to DOE.

Sincerely,

Robert M. Bernero, Director
Office of Nuclear Material
Safety and Safeguards

Enclosure: As stated

cc: R. Loux, State of Nevada
T. J. Hickey, Nevada Legislative Committee
C. Gertz, DOE/NV
M. Murphy, Nye County, NV
M. Baughman, Lincoln County, NV
D. Bechtel, Clark County, NV
D. Weigel, GAO
P. Niedzielski-Eichner, Nye County, NV
B. Mettam, Inyo County, CA
V. Poe, Mineral County, NV
F. Sperry, White Pine County, NV
R. Williams, Lander County, NV
L. Fiorenzi, Eureka County, NV
J. Hoffman, Esmeralda County, NV
C. Schank, Churchill County, NV
L. Bradshaw, Nye County, NV

U.S. Nuclear Regulatory Commission Detailed Comments on
"Adequacy of Management Plans for the Future Generation of Spent
Nuclear Fuel and High-Level Radioactive Waste"

Comment 1

Statements in section 6.2.6 of the report should be expressly attributed to DOE.

Comment 2

The license renewal plans and the decisions concerning such plans as discussed in section 6.3.2 are, more specifically, "utility" plans and decisions and should be so identified.

Comment 3

A more precise description for the "short-term" storage facilities mentioned in the last bullet on page A-3 of the draft report is "storage in an independent spent fuel storage installation or a monitored retrievable storage installation."

Comment 4

There are several references in the draft report to NRC regulations with respect to transportation of wastes (pages 6-10 and A-3). It is clear that DOE must use NRC-certified packages for transportation and that DOE must abide by NRC regulations regarding advance notification of State and local governments (Nuclear Waste Policy Act of 1992 (NWPA), as amended, Sec. 180, 42 USC 10175).

Comment 5

The constraints on storage and disposal that are set out on page A-7 apply to any monitored retrievable storage facility authorized pursuant to Title I of NWPA, as amended, Section 142(b), 42 USC 10162. They do not necessarily apply to a facility established pursuant to a negotiated agreement that is enacted into federal law pursuant to Title IV of NWPA, as amended.

Enclosure

NYE
COUNTY

NUCLEAR WASTE PROJECT OFFICE

September 13, 1993

Mr. Lake Barrett, Acting Director
Office of Civilian Radioactive
Waste Management — RW1
U.S Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Re: Nye County Comments on DOE Report in Response to Section 803 of the Energy Policy Act of 1992

Dear Mr. Barrett:

Please find enclosed Nye County's comments on the report entitled "Adequacy of Management Plans for Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste: A Report in Accordance with Section 803 of the Energy Policy Act of 1992". We regret not having met the August 20, 1993 deadline for public input, but hope there is still time for consideration of Nye County's observations.

In general, our comments are consistent with many others that have come to our attention and essentially elaborate on our scoping comments made at the February 17, 1993 meeting. In essence, we believe that the Report too narrowly construed the Department's mandate by focussing only on spent fuel and liquid defense high-level radioactive waste. The nation will ultimately have to confront the storage requirements of the greater-than-class-C waste. At a minimum, the Department should have constructed its upper reference case to include a reasonable estimate of GTCC waste that will require deep geologic disposal.

Similarly, rather than deferring consideration of thermal load implications of cold versus hot alternatives, such design factors should be incorporated as variables into your scenario development methodology.

Nye County has also reviewed this report looking for indications of the Federal government's long-term intentions at Yucca Mountain. It is clear, for example, that DOE anticipates a larger capacity for a Yucca Mountain repository than the 70,000 mtu limit. Yet, it is unwilling to give serious consideration to the need for a second repository that, by current statute requirements, must be operational before the first repository capacity is expanded. Nye County's fear that Yucca Mountain is the nation's de facto repository site is reinforced by a draft report that puts off consideration of contingencies to Yucca Mountain to so far into the future -- and only after extraordinary sums have been expended for characterization.

Finally, DOE has so carefully constrained its analysis that it provides little public policy insight into the dilemma the country is facing regarding the future of nuclear power, much less with the backlog of radioactive materials that will ultimately require long-term storage.

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REPLY TO:
☐ TONOPAH OFFICE: P.O. BOX 1767 • TONOPAH, NEVADA 89049 • (702) 482-8183 • FAX (702) 482-9289
☐ RENO OFFICE: P.O. BOX 1510 • RENO, NEVADA 89505 • (702) 323-4141

Thank you for the opportunity to comment on this study.

Sincerely,

Les W. Bradshaw
Project Manager

NYE COUNTY COMMENTS ON THE DOE REPORT:
ADEQUACY OF MANAGEMENT PLANS FOR THE FUTURE GENERATION OF SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE

Section 803 of the Energy Policy Act of 1992 requires DOE to submit a report to the President and Congress within one year of enactment. The section specifies that DOE establish "...whether current programs and plans for management of nuclear waste as mandated by the Nuclear Waste Policy Act of 1982 (42 U.S.C. 10101 et. seq.) are adequate for management of any additional volumes or categories of nuclear waste that might be generated by any new nuclear power plants that might be constructed and licensed after the date of enactment of this act." Further, DOE is required to consult with the NRC and EPA on the report's contents and afford other interested parties, including the public, the opportunity to provide information and comment.

At a February 17, 1993 DOE scoping meeting, Nye County advocated that DOE should focus its study on the overall nuclear waste management system, i.e., all categories of currently existing nuclear waste that have the potential of requiring deep geologic disposal, as well as the estimation of waste that can reasonably be expected in the future. The NRC advocated a similar position; the utilities expressed the belief that the scope should be limited to spent fuel.

In essence, DOE's draft report has addressed the letter of Congress's inquiry represented by Section 803, but missed the spirit. DOE limited its scope to spent fuel and defense high-level radioactive waste, as explicitly called for, but completely ignores a large volume of waste that is highly likely to require deep geologic storage, thereby appearing to increase storage space requirements way beyond first repository capacity, even if the 70,000 mtu limit were to be expanded. By not focusing on the entire potential inventory, DOE cannot accurately gauge the incremental effect new reactors will have on the nation's storage capacity.

The current regulations characterize radioactive wastes as high-level, transuranic, low-level and greater-than-class C (GTCC). High-level radioactive waste includes spent nuclear fuel before reprocessing and by-products from spent fuel reprocessing. The spent fuel comes from civilian and defense reactors, while reprocessing-related waste is in liquid form and is planned to be vitrified. Transuranic waste is comparable to high-level waste in terms of toxicity and half-life, but is significantly less concentrated. It consists of contaminated materials, such as clothing, and objects from defense production sites. High-level waste, of course, is slated for deep geologic storage under the civilian radioactive waste program, while transuranic waste is to be stored at WIPP which is managed by DOE's defense program.

Low-level radioactive waste is all other radioactive waste that is neither high-level, nor transuranic. Low-level radioactive waste is classified according to criteria based on concentration of radionuclides (Classes A, B, and C) and is permitted to be stored in near-surface, lined pits that are to be backfilled (such as exists at the Beatty facility).

GTCC waste exceeds low-level limits for Class C, is not high-level or transuranic, and is otherwise not defined. However, NRC has designated GTCC as unacceptable for near-surface storage - in other words, a "home" for this waste has not been established within the country's waste management system. Many people have suggested that GTCC is destined for the civilian repository. If so, its volume would substantially increase the inventory of waste requiring deep geologic disposal. This volume should be considered if only as an alternative scenario.

Finally, a main point of current controversy is the storage configuration of spent-fuel in the repository as dictated by the thermal load scenario that will best fit the repository block's ability to meet the release limit standards, particularly for ground-water travel time and gaseous circulation. Some thermal load scenarios have young (hot) fuel closely packed together to create a heat shield pushing water away from the canisters. Other scenarios call for less dense storage configuration. Obviously, the decision on this design factor will have such a significant bearing on the repository storage capacity that alternative scenarios should be generated for both the "hot" and "cold" scenario.

Virginia Chapter
SIERRA CLUB

Robert F. Deegan
340 Ramapo Road
Virginia Beach, VA 23462

Robert F. Deegan
340 Ramapo Road
Virginia Beach, VA 23462

August 17, 1993

Dwight E. Shelor
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Ave., SW
Washington, D.C. 20585

Dear Mr. Shelor:

Thank you for this opportunity to comment upon your June 1993 draft "Section 803 Report" to Congress on the Adequacy of Management Plans for the Future Generation of Spent Nuclear Fuel and High-Level Radioactive Waste.

The draft report does not adequately respond to the specified requirement for the report in Section 803 of the Energy Policy Act of 1992. Virtually devoid of environmental analysis, the report does not address the glaring inadequacies of management plans for nuclear waste from currently authorized sources. Pertaining to the possible licensing of additional nuclear power plants, it does not analyze the added environmental risks of producing additional nuclear fuel, of the additional on-site risks, of the additional transportation risks of the nuclear waste, or of the additional risks of long-term storage of the nuclear waste. The report does not address the added environmental risks of a second repository which would be likely to be required if more nuclear power plants are licensed. To respond to Congress adequately the report must address the environmental risks in detail.

In light of the inadequacies described above, the report is incorrect in its conclusion that current waste-management programs and plans are adequate for any additional volumes and categories of nuclear waste produced by new power plants. To the contrary, there is every reason to believe that the current inadequacy of DOE management plans for dealing with spent nuclear fuel and high-level waste would be even worse if additional nuclear power plants were to be constructed and licensed.

Please send us a copy of your final report on this matter to the address indicated above.

Yours sincerely,

Robert F. Deegan

Robert F. Deegan
Nuclear Waste Issues Chair,
on behalf of the Club Energy
Committee and Military Impacts
on the Environment Committee

"When we try to pick out anything by itself, we find it hitched to everything else in the universe."

APPENDIX D

COMMENTS OF THE U.S. NUCLEAR REGULATORY COMMISSION

To be provided later.

APPENDIX E

COMMENTS OF THE ENVIRONMENTAL PROTECTION AGENCY

To be provided later.