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Report to the President by the Interagency Review Group on Nuclear Waste Management

March 1979

Washington, D.C.

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MEMBERS OF CONGRESS, GOVERNORS, STATE AND LOCAL OFFICIALS, MEMBERS OF THE PUBLIC

Enclosed is the Report to the President from the Interagency Review Group on Nuclear Waste Management (IRG) established last March at the direction of the President. In October a draft report was offered for public review, and extensive comments were received. This final report presents the findings, policy considerations, and recommendations reached by the IRG as of this date. The IRG has attempted to ensure that this final report accurately reflects the full range of such comments and concerns.

The findings and recommendations contained in this report, reflect the unanimous views of the individual agencies participating in the effort. As appropriate, independent views of some members are also included. The IRG appreciates the extent and quality of public comments it received. These comments assisted the IRG immeasurably in formulating its recommendations to the President.

The IRG is grateful and appreciative of your interest and assistance.

Thank you,

John M. Deutch, Chairman
Interagency Review Group on
Nuclear Waste Management

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PREFACE

The Draft Report to the President by the Interagency Review Group on Nuclear Waste Management was released for public review and comment October 19, 1978. The Report presented the findings, policy considerations and tentative recommendations reached by the IRG. Some 15,000 copies of the Report were issued for review and comment. A total of 45 days were allowed for public review and comment; however comments received after that time period have also been included in this review.

A total of some 3300 comments covering all states have been received and reviewed to date. About three-fourths came from private individuals. A substantial number were from State governments, the utility industry, the nuclear industry, public interest organizations, environmental organizations, academia, and the general business community. Responses were also received from Congress and a number of Federal Agencies.

The responses ranged from brief, one or two sentence letters to very lengthy, substantive documents providing in-depth analysis of the draft report's contents, conclusions and recommendations.

The responses presented a wide range of viewpoints on most of the issues addressed in the IRG Report. Most commenters indicated that the draft IRG report represented an important contribution and significant step forward in addressing the complex issues of waste management programs. However, nearly all commenters sought further clarification of or disagreed with some of the views expressed in the draft report.

The IRG acknowledges and appreciates the extensive participation of the public in commenting on the draft report. Comments have been given careful consideration and were extremely valuable to the IRG in formulating its recommendations to the President. The degree of public response indicates the seriousness and interest of the public in this important national issue. The IRG wishes to encourage continued public participation as the nation's nuclear waste management policies are developed and implemented.

This version of the IRG's Report contains the original text of the draft report plus a summary of the public comment on individual sections inserted at the end of each. An IRG response immediately follows the summary of public comment. These IRG responses reflect a modified or amplified view based on the public comments and/or additional deliberations by the IRG. The original text of the Summary of the Draft Report is included as Appendix H.

This revised report is being provided to the President, together with IRG recommendations which reflect its understanding of the public comment and its current views as indicated in this revision.

INTRODUCTION

BACKGROUND

Since taking office in January 1977, President Carter has taken a series of important actions to address important nuclear issues. As part of the National Energy Plan, the President ordered a review of the U.S. nuclear waste management program. This led to the creation of an internal Department of Energy (DOE) task force which carried out the review and and published a draft report in February 1978. 1/

Setting forth preliminary views on key issues in the waste management area, the DOE task force report highlighted the need to develop a national nuclear waste management policy and integrated program. Further, the report noted that for any nuclear waste management policy to be credible, it must reflect the views of the involved government agencies, the Congress, the States, local governments, industry, the scientific and technical community, and other members of the public.

On March 13, 1978, in response to the findings, the President established the Interagency Review Group (IRG) to formulate by October 1, 1978, recommendations for the establishment of an Administrative policy with respect to long-term management of nuclear wastes and supporting programs to implement the policy. 2/ He also asked for the deliberations of the IRG to provide for appropriate participation by the interested public.

Chaired by the Secretary of Energy, the IRG is composed of representatives of 14 government entities 3/ including

- Department of Energy
- Department of State
- Department of Interior
- Department of Transportation
- Department of Commerce
- National Aeronautics and Space Administration
- Arms Control and Disarmament Agency
- Environmental Protection Agency
- Office of Management and Budget
- Council on Environmental Quality

1/ U.S. Department of Energy, Directorate of Energy Research; Draft Report of Task Force for Review of Nuclear Waste Management; February, 1978.

2/ Appendix A is a representation of the Presidential letter.

3/ Appendix B is a list of the Agency representatives.

Office of Science and Technology Policy
Office of Domestic Affairs and Policy
National Security Council
Nuclear Regulatory Commission 4/

A Technical Advisory Committee was established to assist a special subgroup of the IRG in formulating a description of the state-of-the-art of alternative disposal technologies and developing and analyzing alternative strategies for high-level and transuranic waste disposal. 5/ The Committee membership represented a broad range of scientific, technical, industrial, and environmental viewpoints.

In carrying out the Presidential mandate, the IRG has attempted, by a variety of means, to obtain a broad range of inputs and views from many sources, including Congress, State and local government, Indian nations, industry, the scientific and technical community, public interest and environmental organizations, and the public. 6/

HISTORICAL PERSPECTIVE 7/

The management of radioactive wastes for the past three decades can be characterized by inadequate integration of waste management R&D efforts with those for other parts of the nuclear fuel cycle. This has been caused in part by inadequate perceptions of the additional technological and scientific capabilities needed to develop an acceptable disposal capability (historically assumed to be achievable through isolation of wastes in mined geologic repositories) and in part by low funding levels compatible with a view that the waste management program should focus on only one geologic medium (salt) for HLW disposal and few sites.

4/ The NRC participated in the activities of the IRG as a nonvoting member. In view of its status as an independent regulatory agency with responsibility to regulate certain activities discussed in this report, the IRG's participation does not constitute any endorsement of the report's findings and recommendations.

5/ The work of the subgroup is available in a draft report, "Alternative Technology Strategies for the Isolation of Nuclear Wastes," October 1978.

6/ Activities are summarized in Appendix C, and reported in detail in Summary Report of Public and Small Group Meetings.

7/ This brief perspective emphasizes activities associated with high level waste disposal because of the substantial number of issues associated with this matter. Later sections of the report include background information on other waste types as they are discussed throughout the document.

Previously, very few earth scientists have been involved in either program management or scientific R&D for what is now recognized as a problem whose resolution will clearly require an unprecedented extension of capabilities in rock mechanics, geochemistry, hydrogeology, and long-term predictions of seismicity, volcanism, and climate. Important groups of scientists from disciplines such as materials research and risk assessment modeling have until recently also not been incorporated into the program.

The costs of radioactive waste management have consistently been viewed as insignificant relative to the other costs of nuclear power. Further, the absence of facilities for the ultimate disposal of radioactive wastes have not been seen, until recently, as a potential constraint on uses of nuclear energy.

The increased levels of support, beginning in Fiscal Year 1975 (Exhibit 1), and broader range of disciplines involved have led to a greatly increased accumulation of knowledge within the program. The current rate of growth of relevant knowledge is very large. Confidence has now increased to the point where the majority of informed technical opinion holds that the capability now exists to characterize and evaluate media in a number of geologic environments for possible use as repositories built with conventional mining technology and that successful isolation of radioactive wastes from the biosphere appears feasible for periods of thousands of years. It is important to review some of the past aspects of government management of radioactive wastes so that future difficulties can be avoided without losing programmatic momentum.

Initially radioactive waste was generated by defense-related activities that were driven by overwhelming security priorities and severe time constraints. Wastes in many forms were produced at Hanford, Washington; Savannah River, South Carolina; and at the National Reactor Testing Station in Idaho, and were managed in a wide variety of ways with varying degrees of success. These waste materials remain in existence today and will require extensive and costly efforts for ultimate disposal.

In the 1950's and 1960's, commercial wastes began to be produced in various forms and in increasing amounts. The Committee on Radioactive Waste Management of the National Research Council/National Academy of Sciences evaluated ultimate disposal of wastes and recommended, subject to a number of caveats, disposal in deep geological salt formations.

Attempts to develop methods to do this continued sporadically and at low funding levels through 1975. A demonstration of retrievable storage in rock salt was performed in Kansas in 1969, but for numerous technological and political reasons failed to mature into a waste repository. For awhile the AEC then began to favor surface storage, but this effort also was abandoned.

Exhibit 1

AEC, ERDA, and DOE
Budget Expenditures for
Nuclear Waste Management

Fiscal Year	Budget (millions $)[1/]
1967 and prior years	206
1968	21
1969	26
1970	28
1971	32
1972	46
1973	48
1974	61
1975	94
1976	158
1977	230
Subtotal - actuals	951

1/ All figures are rounded. Includes facility construction as well as operating dollars.

In 1976 there were substantial programmatic changes which began to increase the number of candidate media and areas for consideration; but, the Presidential decision in 1977 to defer commercial reprocessing confronted the technical community with a potential waste form (spent fuel) about which much less is known as compared to the previous R&D effort on the disposal of reprocessing wastes.

Political considerations have also reached new levels of intensity, most notably because of greatly increased public perception and concern with environmental matters. With time, it has become clear that prior concentration on engineering solutions with minimal earth and materials science input has been too simplistic. It is now recognized that a much more broadly based program which addresses fundamental scientific questions within a systems concept is needed; in particular, one which emphasizes flexibility in programmatic and repository design to permit disposal of all types of existing and future radioactive wastes.

NUCLEAR WASTE DISPOSAL AND FUTURE USE OF NUCLEAR ENERGY/NEUTRALITY

Some members of the public have expressed significant concern over the advisability of increasing the U.S. commitment to nuclear power until there is greater assurance that there can be safe storage and disposal of nuclear waste. They point particularly to the hazards these wastes can pose to future generations. Some have proposed linking the licensing of new nuclear power plants to a convincing demonstration that nuclear wastes can be safely contained until decayed to harmless levels.

On the other hand, some members of the public believe that the technology for waste disposal is well in hand and question whether the government is moving quickly enough in developing repositories for high-level wastes and otherwise doing enough to allay public concerns. Generally, this group believes there are limited benefits and considerable economic risks in linking the reactor licensing and waste disposal issues.

Still other members of the public share selected views in common with both of the preceeding groups.

The question of the impact of nuclear waste concerns on the future of nuclear power is quite complex and has not been conclusively addressed at this juncture by the IRG. The IRG is aware that strongly held and differing views on the subject exist. Therefore, the IRG has adopted the following approach for purposes of its report:

- The President should be informed of the nature and intensity of the public views on this issue;

- The IRG's analysis and recommendations should address the nuclear power future neutrally, and

- o an orderly, step-by-step decision-making process that ensures consideration of all facets of the issue and pays maximum attention to the public health and safety should be followed in the development of the policy, plan and program for nuclear waste management.

The IRG recognizes that successful application of the neutrality approach is important to securing broad public support for waste management efforts. The IRG recommendations, therefore, focus on ensuring safe waste management and are not skewed by a desire to either shore up the nuclear option or to undermine it.

The IRG has implemented its views on neutrality in three ways in developing the material in this report. First, the substantial existing inventory of civilian and military nuclear wastes must be managed in the safest possible way and must be subject to the same strict safety criteria applicable to newly generated wastes, despite pressures to be more lenient towards existing wastes. An important question is whether the risks associated with the management of existing wastes are larger than we would be willing to accept if we had a choice, and of course we have such a choice with regard to new waste commitments.

Second, the IRG has reviewed the dimensions and implications of the radioactive waste issue from the standpoint of alternative nuclear growth futures. For example, the magnitude of the required nuclear waste management effort can be considered for three situations: the current waste inventory, the projected waste inventory committed if nuclear power grows to an installed capacity of 148 Gwe by the year 2000, and the projected waste inventory committed if nuclear power grows to an installed capacity of 380 Gwe by the year 2000. This material is presented in the following section of the Chapter.

And third, the IRG has taken care that its conclusions and recommendations are viable, whatever the future course of nuclear power growth, and are neutral as to alternative nuclear futures.

<u>The IRG particularly welcomes public comment on the relationship between waste management concerns and the future of nuclear power</u>.

<u>Public Comment</u>:

Many commenters agreed with the IRG's objective of neutrality on the question of the future of nuclear power. Some of these felt, however, that the IRG had not achieved this objective but in fact had -- either explicitly or by implication -- favored one or another view on the question.

Many commenters disagreed with the IRG's objective of neutrality. Most of these also felt that the IRG was in fact not neutral and usually they perceived the IRG to hold views contrary to their own. Many industry commenters, for example, argued that the IRG's technical findings should have led it to conclude that the waste disposal problem need not impede further expansion of nuclear power. In fact, however, they felt that the IRG recommendations would further delay the disposal of commercial high level waste and exacerbate public concern, and thereby inhibiting the growth of nuclear power. By contrast, many environmental groups argued that the IRG should have explicitly linked the future of nuclear power to a solution of the waste problem. Instead, they said, the IRG had made statements and recommendations designed to support nuclear power. In their view inadequate distinction was made between existing waste which must be disposed of by the best available method and future waste, the generation of which should be made contingent on the existence of truly adequate disposal technology.

Many commenters, including some from state governments, felt that the IRG was being unrealistic in not sufficiently acknowledging that a linkage exists and is increasingly being expressed in state law, in state regulatory actions and by the Nuclear Regulatory Commission. Others, again including some from state governments, felt that the IRG's discussion of the linkage question was not adequate as a basis for informing the President about public views on the subject.

The Nuclear Regulatory Commission said that the relationship between waste disposal and reactor licensing is not legally imposed by the Atomic Energy Act. However, the NRC has determined, as a matter of policy, that it will not continue to license reactors if it does not have reasonable confidence that waste can and will in due course be be disposed of.

Some commenters urged a thorough evaluation of the environmental, social, technical and economic aspects of nuclear power. A portion of these urged that such an evaluation be done comparatively between nuclear power and coal derived power.

IRG Response:

The IRG recognizes that many people perceive that a linkage does and should exist between nuclear waste disposal and the future of nuclear power and that the linkage has been made in some states, in other countries and by the Nuclear Regulatory Commission. The IRG also understands that positive movement toward resolution of the waste disposal problem will not only deal with serious environmental issues, but also influence public perceptions concerning the acceptability of nuclear power and in that sense can be viewed as not being neutral. The IRG feels that its task is to help resolve the nuclear waste disposal problem for its own sake. The future of nuclear power and the relation of this energy source to other energy sources are important questions that will be debated in many forums but the IRG believes it should not participate in those debates. The IRG reiterates its view that standards, criteria, and regulations to protect the public must be developed neutrally.

The IRG emphasizes that the United States possesses significant quantities of existing nuclear waste, much of which derived from sources totally separate from nuclear power, and that even if no new waste were generated by the nuclear power industry, a significant problem of nuclear waste disposal would still exist.

Some IRG members believe that the IRG report does not adequately meet its own stated criteria for neutrality. These members believe the IRG has not adequately described or analyzed the ways in which differences in future nuclear growth might heighten or reduce waste management difficulties. Many of the IRG analyses and recommendations are focused on more near-term issues such as those associated with the existing wastes and first repository. These members believe the report did not adequately analyze the effects of future nuclear growth on the real ability of our technical, political, and social institutions to manage nuclear wastes safely.

Some IRG members believe that the present U.S. commitment to the use of commercial nuclear power should not be substantially increased without convincing assurance arrived at in a public proceeding that nuclear waste disposal can and will be accomplished without unacceptable risks to public health and safety.

SCOPE AND MAGNITUDE OF WASTE MANAGEMENT REQUIREMENTS

Radioactive wastes are produced in a wide variety of activities including research investigations, medical diagnostics and therapy with radiopharmaceuticals, mining of uranium ore, and defense-related nuclear activities, and the operation of commercial nuclear power reactors. During the last thirty years defense-related nuclear activities produced most of the radioactive wastes in terms of volume and radioactivity.

Today, and as projected for the future, the radioactive waste generation rate of the defense-related programs is about constant and small in relation to the future generation of the nuclear power industry. The commercial nuclear power industry has grown during the 1960's and 1970's, and, as a result, has now generated more radioactive waste (measured in terms of cumulative radioactivity) than the past defense-related activities. The annual generation rate of waste from the commercial nuclear power industry will continue to grow as new power reactors come into operation.

Waste consists of radioactive species of almost all chemical elements; some contain naturally occurring radioactive materials and others contain man-made radioactive materials; the wastes exist as gases, liquids, and solids. Yet for all their variety, radioactive wastes have one thing in common: as long as they remain highly radioactive, they will be potentially hazardous. This potential hazard results from the fact that exposure to and/or uptake of radioactive material can cause biological damage.

In man, it can lead to death directly through intense exposure and a variety of diseases, including cancer, which can be fatal. In addition, radioactive material can be mutagenic thereby transmitting biological, damage into the future.

The central scientific fact about radioactive material is that there is no method of altering the period of time in which a particular species remains radioactive, and thereby potentially toxic and hazardous without changing that species. Only with time will the material decay to a stable (non-radioactive) element. The pertinent decay times vary from hundreds of years for the bulk of the fission products to millions of years for certain of the actinide elements and long-lived fission products. Thus, if present and future generations are to be protected from potential biological damage, a way must be provided either to isolate waste from the biosphere for long periods of time, to remove it entirely from the earth, or to transform it into non-radioactive elements.

The President directed the IRG to focus on the means for the safe long-term management and disposal of all types of existing and future wastes.

The major classes of nuclear wastes are:

- High Level Wastes (HLW) are either intact fuel assemblies that are being discarded after having served their useful life in a nuclear reactor (spent fuel) or the portion of the wastes generated in the reprocessing of spent fuel that contain virtually all of the fission products and most of the actinides not separated out during reprocessing. These wastes are being considered for disposal in geologic repositories or by other technical options designed to provide long-term isolation of the wastes from the biosphere.

- Transuranic (TRU) Wastes result predominantly from spent fuel reprocessing, the fabrication of plutonium to produce nuclear weapons, and, if it should occur, plutonium fuel fabrication for recycle to nuclear reactors.[8/] TRU waste is currently defined as material containing more than ten nanocuries of transuranic activity per gram of material. These waste would be disposed in a similar manner to that used for high level waste disposal.

8/ This numerical list is presently under study by NRC and may be increased. If this happens, the TRU waste volumes would decrease. The recategorized wastes would then be low level and suitable for shallow land burial.

- Low Level Wastes (LLW) contain less than ten nanocuries of transuranic containments per gram of material, or they may be free of transuranic contaminants, require little or no shielding have low, but potentially hazardous, concentration or quantities of radionuclides. Low level wastes are generated in almost all activities involving radioactive materials and are presently being disposed of by shallow land burial.

- Uranium mine and mill tailings are the residues from uranium mining and milling operations which contain low concentrations naturally occurring radioactive materials. The tailings are generated in very large volumes and are presently stored at at the site of mining and milling operations.

- Gaseous effluents are released into the biosphere and become thereby diluted and dispersed. (These materials, while important, are not considered further in this report.)

Decontamination and decommissioning (D&D) is an activity that can generate significant quantities of wastes. These wastes are not unique and are categorized in the same manner as explained above. D&D is examined in this report because, until retired nuclear facilities and land are decontaminated, such facilities and land must be considered and treated as a waste storage site; D&D is potentially a source of large quantities of radioactive wastes.

In what follows, a description of nuclear waste management requirements is given in terms of the number of disposal facilities and associated activities required to handle existing quantities of nuclear wastes. In addition, because there are operating commercial nuclear power reactors and a continuing nuclear defense program, there is a requirement to dispose of the waste to be generated over the remaining life of these facilities and programs. These "lifetime" requirements are included in the results which follow.

Exhibit 2 presents the quantities of existing defense and commercial wastes of all types (including spent fuel).

Because it is not possible to predict with accuracy a number of important future decisions which will impact nuclear waste management, the IRG has used two scenarios to illustrate different potential levels of requirements in management and disposal for both existing and future wastes. These requirements are summarized in Exhibit 3.

Exhibit 2

Quantities of Existing Waste

High Level Waste (HLW), thousands of cubic feet	
Commercial	80
Defense	9400
Transuranic Waste (TRU), contained TRU, kilograms	
Commercial	123
Defense	1100
Spent Fuel Discharged from Commercial Reactors	2300 metric tons of heavy metal (MTHM)
Low Level Waste (LLW), millions of cubic feet, buried	
Commercial	15.8
Defense	50.8
Uranium Mill Tailings	140 million tons

Exhibit 3

Nominal "Lifetime" Requirements for Nuclear Waste Management and Disposal

	Case 1 1/	Case 2 1/
Geologic Repositories:		
for defense high level wastes	1	1
for defense TRU wastes	1	2
for commercial high level waste 2/	2	5
Potential Away-from-Reactor Spent Fuel Storage Facilities:		
if repository opens in 1988	3	3
if repository opens in 1992	6	6
if repository opens in 1996	8	9
if repository opens in 2000	12	14
Low Level Waste Disposal Sites:		
commercial LLW (acres required)	300	950
defense LLW (acres required)	140	700
Uranium Mine and Mill Tailings:		
billions of tons	1.9	5.2
number of sites	40	40
Decontamination and Decommissioning Activities:		
number of facilities decontaminated and decommissioned (commercial facilities only)	148	380
Transportation Requirements		
a. Low level waste volume 4/	120	450
b. Number of trips with high level wastes 3/	1400	3200
c. TRU waste volume 4/	6.8	116

1/ Defined in Appendix D.

2/ The requirement for repository space is not sensitive to the decision to dispose of spent fuel or to reprocess the spent fuel and recycle the uranium and plutonium.

3/ The number of trips does not include interim storage of spent fuel in an AFR storage facility. Depending on the date of a repository opening these numbers could be somewhat (50%) higher.

4/ Millions of cubic feet, cumulative through the year 2000.

SCOPE AND CONTENT OF REPORT

The IRG has designed the remainder of this report to include:

- o National goals, planning objectives, criteria and procedures for nuclear waste management to guide policy, planning, program, regulatory and research and development activities.

- o Discussions of technical issues and recommendations for key elements of interim strategic planning bases (which are needed to develop near-term programs, assign priorities, and plan R&D, but which do not prejudge future NEPA or regulatory decision-making requirements) for the disposal of:

  - High level and TRU wastes
  - Low level waste
  - U-mill tailings and
  - Waste from D&D activities.

- o Discussion of institutional Issues.

- o Discussion of Management Considerations including recommendations for follow-on implementation.

- o Work plans for each major type of waste, based on the goals, decisions, and interim strategic planning bases, that:

  - Describe key tasks,
  - Assign those tasks to appropriate government agencies,
  - Schedule achievement milestones against which progress can be measured, and
  - Identify the nature and timing of future major decisions that will either validate or require readjustment of current plans and/or timing.

Any credible, effective approach to program planning must take three types of considerations into account:

<u>Technical</u>. The resulting plan must rest on a well-founded scientific, technical, engineering and environmental bases.

<u>Institutional</u>. The planning and decision-making process must be socially acceptable. That is, it must be open to wide and diverse participation, flexible enough to accommodate changing perceptions, and as sensitive to institutional concerns as it is to technical concerns.

Management. The management approach must be comprehensive enough to integrate all elements into an effective whole and to provide for continuing evaluation of achievements against expectations.

The approach to nuclear waste management planning set forth in this report attempts to meet these planning guidelines.

CHAPTER I

OBJECTIVES AND PROCEDURES

Developing an effective nuclear waste management policy and program entails planning to meet certain objectives and criteria. In addition, nuclear waste management planning involves the development of a decisionmaking process for determining R&D program development, siting, construction, and operating procedures for nuclear waste disposal.

PLANNING OBJECTIVES

There has been and continues to be considerable official and public discussion about objectives that ought to be fulfilled by any system for managing and disposing of nuclear wastes and by the waste management programs that lead to the implementation of the system. Although no objectives have been officially adopted, [1/] consensus seems to have emerged on a number of points; these are enumerated below:

The primary objective of waste management planning is to provide assurance that:

- Existing and future nuclear waste from military and civilian activities (including discarded spent fuel from the once-through nuclear power cycle) can be isolated from the biosphere and pose no significant threat to public health and safety.

The national nuclear waste management policy, plan, and program must meet additional sub-objectives.

Technical Objectives

- The selected technical option must meet all of the relevant radiological protection criteria as well as any other applicable regulatory requirements; although zero release of radionuclides or zero risk from any such release cannot be assured, such risks should be within pre-established standards and, beyond that, be reduced to the lowest level practicable.

1/ These planning objectives are not intended to preempt the activities of the regulatory process wherein objectives, standards and criteria will be established as a basis for licensing, regulation, and compliance. Such activities include, for example, proposed environmental protection criteria for radioactive wastes (summarized in Appendix E) on which EPA is now seeking public comment, and proposed goals for waste management on which NRC is now seeking public comment.

- The technology selected for waste disposal, as well as the reasons for its selection, must be well understood, clearly articulated, and widely accepted.

- The existence of residual technical uncertainties must be recognized and provided for in the program structure.

Objectives Related to Implementation

- The paramount consideration must be the public health and safety. The program should explicitly include consideration of all aspects of the waste management system including safety, environmental, organizational, and institutional factors.

- The responsibility for establishing a waste management program shall not be deferred to future generations. Moreover, the system should not depend on the long-term stability or operation of social or governmental institutions for the security of waste isolation after disposal.

- The capability to deal with a wide range of alternative situations in the future must exist. The basic elements of the program should be independent of the size of the nuclear industry and of the resolution of specific fuel-cycle or reactor-design issues of the nuclear power industry.

- Appropriate cost of storage and disposal of any waste generated in the private sector should be paid for by the generator and borne by the beneficiary.

- Concerns for security and safeguards should be reflected in the program and system design.

- Budgetary and cost considerations, while important, should not dominate the design of the program or system.

Public Comment:

Several commenters stated that a clear objective for waste management implementation as opposed to planning was never formulated. Other commenters suggested that the implementation objective be defined as "the primary objective of federal waste management policies and programs is the permanent isolation of hazardous radioactive materials from the biosphere."

Some commenters pointed out that there is a difference between policy planning and operational objectives. The IRG proposed objectives obscure this fact and as a result substantial confusion was created. For example:

- There is confusion between release and risks, that result from the possibility of release. Because of the time frames involved, it is not possible to reduce risks to pre-established standards; the goal should be to reduce releases. The acceptable level of possible releases is still to be determined. Exposures are not relevant because we cannot predict either the population at risk or the change in radiation protection standards with time.

- Flexibility is commendable, but it is unclear how it will be incorporated into a program of manageable scope.

- It has been assumed that nuclear waste management costs will be a small portion of electricity generating costs. The question is how costs will be equitably distributed, especially if an implementation program fails and extensive remedial action becomes necessary.

Some commenters also stated the language in the objective statement could be interpreted as proposing a new general standard for radioactive waste activities, since current statutory standards and proposed regulatory standards related to such activities are based upon a criterion of protection against unreasonable risk to health and safety of the public.

IRG Response:

In stating its primary objective, the IRG did not mean to restrict its applicability only to waste management planning and thereby exclude program implementation. The IRG also now finds that the phrase "to provide assurance" can be misinterpreted to suggest that perhaps the waste management program need not actually strive to meet the objective. Therefore the phrase should be dropped.

In reviewing the proposed alternative definition, the IRG finds that the word "permanent" may create a presumption that perfect isolation is possible. As the IRG has noted, however, zero release of radionuclides cannot be assured.

Accordingly, the IRG would now state:

That the primary objective of waste management planning and implementation is that:

> "Existing and future nuclear waste from military and civilian activities (including discarded spent fuel from the once-through nuclear fuel cycle) should be isolated from the biosphere and pose no significant threat to public health and safety."

As noted in the draft report, this objective is not intended to preempt the activities of the regulatory process wherein objectives, standards, and criteria will be established as a basis for licensing, regulation and compliance.

"The IRG feels that the first technical objective was mis-stated and wishes to restate it as follows:

> The selected technical option must meet all of the relevant radiological protection criteria as well as any other applicable regulatory requirements; although zero release of radionuclides cannot be assured, any potential releases should be within preestablished standards and, beyond that, be reduced to the lowest level practicable."

The IRG agrees that incorporating flexibility into a program of manageable scope is difficult. Yet the IRG thinks it is both necessary and possible. The IRG's recommendations have tried to do so.

The IRG agrees that finding a methodology for calculating waste management costs that ensures equitable distribution will not be easy. This subject is being given careful attention, however, and in due course proposals will be published for public review. Although total equity may not be achievable, every effort must be made to ensure that the principle of equity is built in to the maximum extent possible.

THE DECISION-MAKING PROCESS

The decision-making process for program development, siting, construction and operating issues related to nuclear waste disposal must meet five important criteria. First, it must be neutral to future application of nuclear technology. Second, it must be reasoned, open, and accessible in order to ensure broadly based involvement of the States and local governments, interest groups, and citizens in the planning and decision-making processes of the program including mechanisms for outside scientific and technical review on a continuing basis. Third, every reasonable effort must be made to inform and educate the public about the technical and institutional aspects of the program, and to facilitate discussion of these matters among various segments of the public and the government. Fourth, the requirements of NEPA must be fully met. Finally, decisions leading to waste emplacement should be reversible if additional information suggests that such a course of action is warranted.

Key elements of the decision-making process requiring special emphasis are:

- The development of both an interim and final strategic planning base for the waste management program

- The development of an overall plan to implement requirements of the National Environmental Policy Act (NEPA)

- o The development of criteria and standards

- o Operation of the Regulatory programs and the licensing process

- o Determination of facilities subject to licensing.

Each element is summarized in turn in the remainder of this chapter.

Development of an Interim Strategic Planning Basis

It should be made clear that a number of different approaches to nuclear waste management are possible. There will be a continuing need for flexibility in planning as well as an opportunity to adjust the program to reflect the results of new developments in both the technical, social and institutional areas of nuclear waste management. Not all decisions can or should be made now. However, a clear interim strategic planning basis must be set forth to develop near-term waste management programs, assign priorities and plan R&D programs prior to completion of the NEPA process and selection of a strategy. Elements must include:

- o assignments of Federal agency responsibilities

- o identification of areas where additional planning, evaluation,, assessment, or long-lead time technical and scientific research must be done;

- o identification, assignment, and completion of major environmental review, standard setting and licensing activities;

- o provision for appropriate State, local and general public consultation; and

- o development of schedules for meeting the many separate tasks which must be completed;

- o provision for adequate resources to complete these tasks;

- o development and submission of requisite legislative recommendations.

These elements are required to ensure that, taken as a whole, this country is moving along a course which, at its conclusion, will permit implementation of a nuclear waste management program meeting basic environmental and safety requirements in a manner which is socially acceptable, economically feasible, and consistent with general nuclear policies.

Implementation of an overall strategic planning basis will involve a series of major decision points based on environmental reviews, standards setting and licensing procedures, R&D findings, State and local decisions and Congressional actions. Successful implementation depends on satisfactorily passing such points, and failure to do so, whether because of technical limitations, policy constraints, or timing difficulties, would require modification of the strategy approach selected.

In the meantime, Federal actions regarding the management of high level nuclear wastes must not prejudice the final choice of strategies for the disposal of high level waste. Nevertheless, a strategic planning basis is needed because near term waste management programs must be developed to assign priorities and plan R&D program prior to completion of the NEPA process and selection of a strategy.

Public Comment:

Comments on the concept of an interim strategic planning basis and the appropriate role of NEPA review were extensive and divided.

Many commenters, particularly industrial organizations, argued that the IRG's insistence on the need to make only interim or tentative decisions in order to satisfy NEPA and its tendency toward delaying decisions in order to accumulate additional information, are inappropriate and unnecessary.

Many other commenters, particularly environmental and other citizen groups, argued that the specification even of an interim strategic planning basis prior to NEPA review goes further toward decisions than is permissible under the law.

Many industry and utility comments expressed concern that, underlying much of the draft report's discussion of the relationship of NEPA to the implementation of a rational nuclear waste disposal program seems to be the unstated premise that the program will only satisfy NEPA if it utilizes the perfect geological medium, the perfect site and the perfect design. The commenters believed that this is an invalid premise, both legally and technically. In their view NEPA does not require that the solution selected be the "perfect" one; all that is required is that it be an acceptable one, chosen, after consideration of reasonable alternatives.

Another concern expressed in industry and utility comments was that the IRG report lacked a sense of urgency with regard to recognizing both the need for and the appropriateness of early implementation actions. It was felt that NEPA requirements were overstated and unnecessarily introduced as a barrier to near-term actions. Some argued that Congress should directly resolve this apparent dilemma by directly mandating that certain actions should be taken. In direct contrast, many environmentalists stated that while the concept of an interim strategic planning bases was consistent with NEPA, any proposal to pursue early high level or TRU repositories would prejudice the outcome of future NEPA reviews.

IRG Response:

The IRG wishes to reiterate in the strongest possible way its commitment to the careful application of the NEPA process and other step-wise decision-making processes. The concept of an Interim Strategic Planning Basis is directly designed and intended to avoid any preemption of this process before completion of all necessary environmental reviews. The IRG believes this approach to be both sound and fully compatible with NEPA requirements.

The IRG agrees that decision making need not be delayed until the "perfect" solution has been found. However, it is still necessary in the NEPA review for the decision maker to consider whether the need to take action now outweighs the benefit of waiting for additional information to be made available at a later date. Issues of this kind are judgmental in character and their evaluation would benefit greatly from technical peer review and public comment.

The IRG recognizes that many members of the public and industry feel a sense of urgency with respect to seeing the Government achieve concrete progress in the waste management program. This urgency cannot be ascribed to any imminent public danger from existing waste and spent fuel now stored at power reactors. However, there is a need to be assured that present waste management programs are proceeding in the proper direction and using the proper approaches to meet fundamental objectives. The IRG is therefore more more concerned about good decision-making today than about past and high-visibility activities which may prove, in retrospect, to have been inappropriate or ill-considered. The need for care in decision-making remains, and applies equally to all branches of Government. The needed care, however, does not preclude early decision-making or other early actions. The IRG is convinced that all of the recommendations which it has developed or to which it is giving serious consideration are fully compatible with these principles and should not prejudice the outcome of future NEPA reviews.

Development of an Implementation Plan for NEPA Requirements

NEPA requires that environmental factors be considered along with economic and technical factors in Federal agency planning and decision making, and that agencies prepare environmental impact statements (EISs) as input for decisions on all major Federal actions that significantly affect the environment. In the area of nuclear waste management, both programmatic EISs and site-specific EISs will be required as input for decisions.

The choice as to which technical strategy is finally adopted must await the publication of an appropriate EIS and its adoption through the NEPA process. The EIS must not only assess the environmental consequences of the proposed course of action but must also consider possible alternatives to the proposed action including no action. The EIS must be published in draft form and circulated for comment both inside and outside the Government. A final version incorporating the comments, where appropriate, must be published before the proposed course of action can be adopted. An EIS is also required to provide a basis for the choice of any particular location for a waste disposal facility.

To integrate the efforts of DOE, NRC, and EPA to systematize NEPA documentation for waste management, the IRG recommends that each agency initiate the preparation of comprehensive plans for meeting those NEPA documentation requirements applicable to its specific areas of responsibility in a timely and coordinated manner. These NEPA plans should detail:

- o Anticipated decision points potentially leading to major federal actions that will have a significant environmental impact;
- o Timing of such decisions;
- o Potential range of alternatives for decision; and
- o Schedule for preparation of environmental documentation (assessments, reports, impact statements) needed as input to those decisions.

When developed, these plans should be provided to CEQ and the public for comment. This planning activity should parallel ongoing NEPA activity.

Public Comment:

The recommendation for each agency to initiate preparation of comprehensive plans is criticized as inadequate. Agencies other than DOE, EPA and NRC may be involved. A mechanism is needed to coordinate individual agency plans into a composite or "master plan" for NEPA activities and schedules associated with nuclear waste management. This would minimize duplicative efforts, recognize the responsibilities and goals of each agency, and contain formal mechanisms to obtain public and agency comments on the overall plan.

A further point raised was that programmatic decisions should not be subject to duplicatory review during the regulatory review process.

IRG Response:

The IRG views the development of adequate NEPA plans as an urgent and important activity.

The IRG recommendation, if implemented, would ensure substantial public participation in the preparation of final NEPA plans through review of draft plans and provide for a substantial role for CEQ. The IRG intended and expects that CEQ would perform any needed overview and coordination of the DOE, EPA and

NRC NEPA plans, taking public comments into account. In addition, agencies would be expected to share with each other draft versions of their NEPA plans and to solicit comments. Additional coordination mechanisms appear unnecessary.

The IRG agrees that duplicatory activities should normally be avoided, and would be avoided with adequate planning. For example, DOE would be expected to incorporate in its NEPA Plan needed activities of non-regulatory agencies just as in the preparation of its waste management plan. (A possible example involves actions required of DOI in permitting the withdrawal of public lands for possible siting of waste management facilities.) A coordinated effort preparing the necessary NEPA documentation, as recommended will help assure complete coverage of issues and avoid unnecessary duplication of effort.

Development of Criteria and Standards

Various criteria and standards for nuclear waste management are being developed by DOE, EPA, and NRC. EPA's standards on acceptable levels of radioactivity in the environment are general rather than site-specific or method-specific. EPA will provide:

- o General criteria, which will be applicable to all waste management options. These proposed criteria will be issued in draft form for public comment in November 1978, and will be reviewed by the various agencies involved.

- o Numerical standards for each type of waste. EPA is developing generally applicable environmental standards for the disposal of high level waste and discarded spent fuel; these standards will be issued in draft form for public comment in December 1978. However, standards for the other types of waste are not planned to be available until 1983 to 1985.2/

The IRG recommends that the EPA schedule for standard setting activities be accelerated. The regulatory agencies have proposed such an accelerated schedule and it is detailed in the work plans in Chapter V. The IRG welcomes public comment on the proposed accelerated schedule, particularly with regard to the timing and priorities reflected in the schedule.

2/ DOE, EPA, and NRC have studies underway on the suitability of land burial of low-level waste, ocean disposal of low-level waste, the handling of existing mill tailings and other nonfuel-cycle wastes, and decommissioning. The results of these efforts will contribute to the development of needed standards.

NRC develops criteria and standards applicable to specific nuclear waste disposal facilities and issues appropriate regulations. NRC does not consider it practicable, necessary or acceptable to postpone the development and issuing of NRC regulations until EPA standards are promulgated. For example, regulations on uranium mill tailings will be issued in draft form in late 1978, but final EPA general standards may not be available for several years. When EPA final standards are issued, NRC regulations must be brought into conformity. Similarly, for facilities not licensed by the NRC, DOE will not delay developing and issuing criteria and standards until EPA standards are available.

EPA, NRC and DOE agree that the risk of NRC's and DOE's having to make any major changes in its regulations is small. Nevertheless, to minimize the amount of revision required by the timing of issuing criteria and standards on wastes other than HLW, the IRG recommends that EPA in consultation with DOE and NRC should prepare a position paper by mid-1979 that sets forth:

- o Written guidance in advance of issuance of EPA standards, indicating EPA's final proposed approach in developing specific standards for various classes of waste, based on and understanding of:
  - Possible form of future radioactive waste standards
  - How the new standards relate to past EPA standards
  - Applicability of such concepts as feasibility (e.g., best available technology), unacceptable risk, and nondegradation of the environment to waste disposal problems
  - Considerations other than risk for establishing standards
  - Information requirements
- o Discussion of the relationship between EPA standards and standards set by DOE and NRC
- o Upper limits of risk associated with radioactive waste
- o Discussion of the relationship between man-made radioactive waste and naturally occurring radiation.

This position paper should be reviewed by the affected agencies for its programmatic and budgetary implications and by the public. It should then be integrated into the interim strategic planning basis and development of long term waste management plans.

Another issue which directly relates to who or when the agencies need standards is how to handle existing wastes, facilities or sites as opposed to what criteria, standards and controls will be applied to waste in the future. This is a problem faced whenever standards are developed for an ongoing activity. It is further complicated in the case of radioactive waste by the volume and intensity of the material presently on hand. The determination of the applicability of new standards to existing waste is properly addressed in the standards setting process and no blanket decision is proper at this time.

There is a need to develop a plan for interagency action to clearly differentiate between the actions necessary to establish a plan for future wastes as opposed to remedial actions for existing wastes. It is possible that the cost and radiation exposures which would result from remedial action would indicate solutions from those for waste yet to be generated. The agencies and States have worked together on several such programs, e.g., abandoned uranium tailings piles, phosphate waste. This type of cooperative effort can continue in parallel with the development of disposal methods for future waste.

In the interim, to ensure the nuclear waste management program proceeds expeditiously, the IRG recommends:

- EPA, NRC, and DOE be provided with the necessary resources to accelerate development of criteria, standards, and regulations.
- DOE take the lead in devising the actions needed to apply the new standards to previously disposed of waste (including waste produced from decontaminating and decommissioning old facilities). This task should be undertaken as a major part of the ongoing interagency waste management planning effort headed by DOE.

Public Comment:

Comments on the IRG recommendation to accelerate the development of EPA standard-setting activities varied considerably. All commenters, however, appear to agree on the following issues fundamental to standard-setting activities:

- standards are needed to permit the waste disposal program to proceed on an adequate basis
- integration of regulatory and standard-setting programs into the overall implementation of a waste management solution is crucial
- development of standards and criteria is an area which deserves further examination

- o mechanisms should be developed to assure that all regulatory standards and actions are carried out in a timely fashion

- o recommendations in this area should not be limited to EPA standard-setting activities, but also apply to NRC and DOE programs.

Comment from both the industrial sector and the environmental community urged the acceleration of EPA standards particularly to instill confidence that proper protection of the public's health and safety is being provided. They expressed the concern that early standards are essential to permit the waste management program to proceed expeditiously. Moreover, the IRG recommendations were said not to go far enough to:

- o assure that the necessary budgetary support, personnel, organizational, technical and scientific resources will be provided to the regulatory agencies so that the standard-setting activities can be accelerated

- o coordinate efforts among EPA, NRC and DOE to avoid duplication of effort and to assure compatibility of scheduled efforts and goals

Comment from the environmental community pointed out that currently the development of waste isolation technologies is running on a parallel track with EPA and NRC development of criteria for waste disposal. The IRG was urged to consider the fact that it is more sensible to defer the choice of waste technology so that the ultimate choice of disposal options can indeed meet EPA and NRC's criteria. Developing criteria should be ahead of decision-making so that proposed geologic and geographic sites can be examined for their conformity. Development and issuance of criteria should follow a logical sequence. Moreover, expediency should not preclude or prejudice quality.

The environmental community also stated that EPA and NRC have been hampered by a legitimate lack of scientific data and investigatory research; DOE, in their view, has shown little interest in such work and has consequently indulged in premature conceptual and design work. Particularly needed is scientific input from the disciplines of ecology and radiobiology.

The Nuclear Regulatory Commission commented that the development of standards and criteria is an area which deserves further examination:

- existing statutes lead to some duplication of regulatory efforts;

- since NRC regulations must be brought into conformance with EPA general standards when they are issued, schedule mismatches may result in delays in NRC licensing reviews.

- the problems are not amenable to easy resolution. In any event, resources should be available to NRC to develop the independent technical capability necessary to implement the licensing process. It is necessary to ensure that NRC's licensing capability keeps pace with the DOE program in order that regulatory uncertainties do not necessarily impede the implementation of the national waste program.

IRG Response:

The IRG agrees that standards are needed to permit the waste disposal program to proceed on an adequate basis, that the integration of regulatory and standard setting activities into the overall implementation of a waste management solution is crucial. Recommendations in this area should not be limited to EPA standard-setting activities, but also apply to NRC and DOE programs. The IRG also agrees that greater emphasis on the development of regulatory activities is of utmost importance. This includes providing the necessary budgetary personnel, organizational, technical and scientific resources.

The division of labor between EPA and NRC by which the former issues general guidance or generally applicable environmental standards and the latter implements these through regulations and by licensing actions seems appropriate.

There is need to address whether it is practicable and sound for EPA to issue general guidance or set generally applicable environmental standards derived from health effects and not specific technology capabilities. Because this is an issue that transcends radioactive wastes or even the full fuel cycle, it must be addressed in the more general context of radiation protection. The IRG recommends that this issue be brought to the attention of the Interagency Task Force on Ionizing Radiation for consideration and advice.

EPA guidance should recognize the large range of uncertainties involved in determining precisely the performance of waste management technology -- particularly high-level waste repositories. EPA guidance should permit NRC in its implementation and licensing process to account for these inherent uncertainties.

If DOE and the private sector are to have adequate and timely guidance, the existing problems between NRC and EPA in the nuclear waste area must be dealt with on a time scale somewhat faster than any mechanism to address the general problem is likely to operate. Therefore efforts, including the 1979 guidance paper, should be taken to ease the problem. The two agencies should convene immediately to delineate issues concerning scheduling of regulatory actions, methodologies and procedures used by each in exercising its authority, and divisions of responsibility. The IRG recommends that the two agencies be requested by the President to complete a Memorandum of Understanding within three months that sets out agreement on division of responsibilities, methodologies, procedures and regulatory calendars that are accelerated to be more responsive to the needs of the Nation. DOE should provide information on its program planning needs to NRC and EPA for their use in developing their regulatory calendars.

In drafting the MOU between them, the NRC and EPA should consider what would be the optimum approach for EPA to exercise its authorities with respect to nuclear waste under the Marine Protection, Research and Sanctuaries Act and the Clean Air Act as amended and identify what actions, if any, they think are necessary.

Until EPA criteria are available, DOE activities will continue to conform to DOE established criteria. DOE is working with EPA and NRC in their standard setting role and will conform to their final standards.

Regulatory Program and Licensing Process

The primary objective of NRC's regulatory program for radioactive waste disposal is the protection of the public health and safety. In addition, under NEPA, NRC has the responsibility in its licensing actions to protect the environment. These objectives are realized through the development of criteria, standards, and regulations; establishment and use of a licensing process, and compliance (enforcement). The regulations establish not only technical requirements, but also administrative procedures for ensuring Federal agency, State and local government, and public participation.

The development of NRC criteria and standards begin with consideration of the overall requirements for the protection of the public health and safety and of the environment; Federal rules such as Department of Transportation regulations; existing EPA environmental criteria and standards for waste management; and public values and concerns. Specific criteria and standards are then developed for site suitability; facility design; operation, decommissioning or closure; and waste classification, form and packaging. Before these criteria and standards are promulgated, they are subjected to government, industry, and public review through the rulemaking process which includes the opportunity for public hearings.

NRC, in its licensing process, independently evalutes the information provided by the license applicant. Specifically, information on the disposal technologies being considered is reviewed. Where necessary information is lacking, the NRC either directs the applicant to develop the information or obtains the information itself.

The NRC will require the applicant to furnish to the involve State and local governments, copies of the application, environmental assessments, and other supporting documentation. The involved State government may participate in the view of the site-specific Environmental Impact Statement and in the licensing hearings. However, the determination of safety remains with the NRC.

Compliance with license conditions is accomplished through monitoring and inspections.

By carrying out all of these responsibilities, the NRC provides an independent overview of the process in a regulatory context.

Licensing Determinations

All commercial nuclear activities and facilities, except those that involve minimal quantities of special nuclear materials, are subject to licensing by the NRC. 3/ Congress has also considered the matter of which DOE facilities, should be subject to license and present legislation designates the following DOE waste disposal and handling facilities:

- Facilities used primarily for the receipt and storage of high-level radioactive waste produced from licensed activities

- Facilities authorized for the express purpose of subsequent long-term storage of high-level radioactive waste generated by DOE which are not used for, or are part of, R&D activities.

However, the question of whether or not to license other DOE waste facilities continues to be a matter of public discussion. The IRG has considered this matter and identified the following three principles as relevant to the matter of which DOE nuclear waste facilities should be licensed:

- National security guarantee. Consistent with past expressions of Congressional intent, no DOE facility should be regulated by an outside authority if such regulation would potentially inhibit the production of materials for national defense or lead to the disclosure of national security information.

3/ Under Section 274 of the Atomic Energy Act, the NRC may relinquish and and the individual States may assume regulatory control over byproduct, source, and small quantities of special nuclear material. (NRC may not, however, relinquish control over the disposal of HLW or other wastes the NRC determines should be disposed of under NRC license.) These Agreement States apply criteria, standards, and other requirements in their licensing process similar to those promulgated by the NRC.

- Equivalent protection. The extent of the public's exposure to nuclear waste materials does not vary by ownership of the facility or origin of the material. Thus the public must be assured equivalent protection from material from both Government and non-government sources.

- Independent regulation. In the area of nuclear energy, the public is best served by independent regulation consistent with national security guarantees. The Congress clearly intended this in the Energy Reorganization Act of 1974.

These principles can, in some cases, be in conflict. Hence an appropriate and judgmental balance must be drawn among them.

The IRG considered the following three alternative options to define the degree of licensing coverage appropriate for DOE facilities.

1. The status quo, as contained in existing legislation.

2. An extension of NRC licensing authority (requiring new legislation) primarily to incorporate licensing of new DOE facilities for disposal of TRU waste and nondefense low-level waste, or

3. A further extension of NRC licensing authority to incorporate all new DOE post reprocessing waste facilities and interim storage as well as disposal of waste from both the defense and nondefense programs.

Other alternatives, exceeding the last of the three above in scope, are theoretically possible but were not viewed as practicable for consideration.

All members of the IRG recommend that an extension of licensing to the degree associated with alternative 2. above be adopted and that the DOE submit appropriate legislation to the Congress to accomplish it. Some members of the IRG believe that a still further extension beyond alternative 2 may be warranted.

Two significant issues must be considered in arriving at the appropriate judgment.

First, care must be taken that licensing of defense facilities not reveal aspects of our defense knoweldge to other countries and/or delay our ability to respond to changing world situations. Similarly, care must be taken that additional licensing requirements not divert resources at NRC and DOE away from higher priority activities without any significant gain in safety. Because of these consideration some members of the IRG prefer Alternative 2 which would limit extension of licensing only to disposal activities and in such a way as to minimize adverse consequences to the defense program. Other members of the IRG believe, however, that a further extension, as in Alternative 3, could be accomplished in a way that would allow for protection of important national security considerations; and that the additional resources required are justified by additional assurance of safety to the public.

The IRG agrees that alternative 2 above should be described in detail as set forth below:

- Commercially-generated spent fuel. Commercially-generated discarded spent fuel is not presently considered to be nuclear waste. Nevertheless, the disposal of such material presents hazards similar to those encountered in the disposal of HLW, and therefore should be licensed. The NRC could designate commercially-generated discarded spent fuel as HLW through rulemaking. Alternatively, specific legislation could require the licensing of any disposal in DOE facilities of such material. In any event, any DOE-owned new Away-From-Reactor (AFR) facility used to store commercially generated spent fuel should be licensed, since AFR storage is a substitute for commercial storage, which is subject to licensing. Legislation will be required.

- TRU Waste. Although disposal of TRU waste generated from military activities is not now subject to licensing, it should be since the permanent disposal of such material presents long-term hazards comparable to those encountered in the disposal of HLW, which is licensed. Legislation will be required.

- Uranium mill tailings. Legislation now before Congress redefines "byproduct material" to include radon and radium in uranium mill tailings. If the legislation is approved, new mill tailings would be generated and managed under NRC regulatory control.

- Intermediate-scale facilities (ISF). If an ISF is to be used for permanent disposal of spent fuel, HLW, or TRU waste, that facility should be subject to licensing. Legislation will be required.

- New Nondefense LLW Disposal Sites. Commercially controlled shallow land burial of LLW is already subject to licensing. Existing LLW burial sites operated by DOE are associated with the defense program and should continue to be exempt from licensing. However, if DOE acquired any existing commercial LLW site or opened a new nondefense LLW site, such sites should be subject to licensing. Legislation will be required.

Whether licensed or not, all DOE waste management activities will be subject to EPA general criteria for radioactive waste and EPA numerical standards for specific waste types.

The IRG particularly welcomes public comment on the proposed extent of licensing and to what degree, if any, further extension would be appropriate and desirable.

Public Comment:

The IRG's recommendations for extension of NRC's licensing authorities received substantial comment particularly with regard to the IRG's failure to:

1. adequately define the purpose or explain the necessity of the extension of NRC licensing

2. describe and discuss options intermediate to Options 2 and 3 or provide the basis for presenting and considering only these options for extending NRC's authority; and,

3. consider alternative regulatory procedures which may not amount to licensing, but would insure adequate safeguards for protection of public health and safety while not jeopardizing national security interests.

Several commenters addressed the specific options presented in the IRG draft report. In general, these comments urged either maintaining the status quo and not extending NRC licensing authorities or licensing all facilities including research and existing DOE facilities. A comment specific to Option 2 was that since non-Government TRU wastes will not be encountered in the future unless a decision is made to permit reprocessing, there is no apparent safety or environmental gain to be achieved by extending NRC licensing to the level proposed in Option 2.

Particular comments which were raised in support of not expanding current licensing authority consisted of the following:

- Prior performance of DOE and its predecessor agencies has protected public health and safety in their operations. Extension of licensing does not necessarily ensure that increased public health and safety will result. The keys to safe operations are adequate based on generally accepted standards, a good operating personnel training program, and frequent and rigorous inspections;

- o Licensing of DOE facilities would result in unnecessary and redundant regulation and delay. It should not be done unless the costs can be demonstrated to be justified when compared to the benefits to be derived by the public;

- o NRC licensing authority should not be extended merely to increase public participation or to achieve public acceptance of waste management projects at specific locations;

- o NEPA review on a project-by-project basis will accomplish all that is sought from the licensing process from a safety, technical and environmental viewpoint.

Particular comments raised in support of extending NRC licensing consisted of the following:

- o Past performance of DOE and its predecessor agencies has been inadequate and irresponsible. Extension of licensing to DOE facilities would insure that increased public health and safety measures would be incorporated into the design of waste facilities such that past mistakes would not be repeated;

- o Extension of licensing authorities would eliminate double standards, insure upgrading of existing facilities, generate more public confidence, result in adequate NEPA review, and force consideration of health, safety, technical and environmental issues in decisions concerned with construction of new facilities.

- o Extension of licensing to DOE facilities would insure that NEPA considerations were better integrated on a project-by-project basis into the DOE decision-making process with respect to new facilities.

- o Whether or not licensing should be extended should not depend on who is managing the waste facilities but solely on the potential hazards posed by them. This would be consistent with the IRG's stance of neutrality in managing the existing inventory of wastes and the development of criteria, standards development of criteria, standards and regulations to be applied thereto;

- o NRC regulatory procedures can be designed in such a way to protect public health and safety while not jeopardizing national security. Hence, the arguments regarding the risk to national security are not relevant or appropriate.

Several commenters offered discrete alternatives to the options contained in the IRG report. These included:

1. Extend licensing to cover new DOE interim spent fuel storage facilities and non-DOE, non-defense low-level wastes (i.e. Option 2 but excluding TRU);

2. License all new and existing sites. Bring closed sites into conformance with new standards and criteria;

Some commenters urged that procedures for licensing reactors not be applied to waste disposal facilities, but that NRC institute a step-by-step licensing process which would consist of the following:

- Step 1: a license for testing based on site-suitability criteria

- Step 2: a license for intermediate scale facilities as part of the step-wise progression to a repository

- Step 3: a license for full-scale repository operations

Each step would be contingent upon the successful conclusions of the previous one.

IRG Response:

The IRG decided to define in detail in the draft report only the licensing extension on which all members agreed (i.e. Option 2). It recognizes and agrees that there are numerous other options in addition to Option 2 and 3 which could be defined. It chose not to address the matter in further detail at that time in order to address other issues on which agreement could be reached. Subsequently, the NRC Authorization Bill for FY 1979 has directed the NRC to conduct a study concerning the extension of the Commission's licensing or regulatory authority over nonlicensed Federal nuclear waste facilities.

The IRG still believes that a licensing extension at least as far as Option 2 should be proposed by legislation and now believes that the forthcoming NRC licensing study should be completed prior to consideration of extension beyond Option 2.

CHAPTER II

TECHNICAL STRATEGIES FOR HIGH-LEVEL AND TRANSURANIC WASTES

The success of the program for the management and ultimate disposal of radioactive wastes critically depends upon the choice of technical 1/ strategies. The IRG has focused most attention on issues related to high-level and TRU wastes.

CANDIDATE TECHNOLOGIES

Six candidate technologies have been examined for the ultimate disposal of HLW and TRU wastes:

- Placement in mined repositories
- Placement in deep ocean sediments
- Placement in very deep drill holes
- Placement in a mined cavity in a manner that leads to rock melting
- Partitioning of reprocessing waste, transmutation of heavy radionuclides, and geologic disposal of fission products
- Ejection into space.

Of the six options, mined repository (i.e., in geologic formations) disposal will be available soonest, with deep ocean sediment, and deep drill hole disposal perhaps 10-15 years away from being able to begin implementation. Transmutation, rock melting, and space disposal are even more distant because of the scientific, engineering or institutional problems that must be overcome.

Public Comment:

Comments were received on the detailed technical aspects of the six candidate technologies. These were directed to the Office of Science and Technology Policy for consideration in preparing the final version of the technical appendices of the Report of Subgroup I of the IRG on Alternative Technology Strategies. No further report on these comments will be made

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1/ Institutional Issues and Management Considerations are discussed in subsequent chapters.

here except to the extent that they bear on the general conclusions and technical findings of the IRG. The appendices on the status of knowledge which have served as the technical basis for the IRG's review of the high level and transuranic waste disposal problems will be amended as necessary in light of the public comment and will be published in final form.

With respect to the judgment contained in this section when implementation might be able to begin for the various technology options examined, only two points were raised:

- The rock melting concept should be associated with deep ocean sediment and deep hole disposal in the 10-15 year horizon

- Disposal in deep ocean sediments could be available earlier if the funding levels for the program were increased

Other comments on the discussion of alternative technology options included:

- Too much emphasis was placed on mined repositories.

- Although mined repositories might represent the best near term candidate technology, they do not necessarily represent the best one.

- Technologies other than mined repositories are too speculative and exotic to warrant funding.

- Disposal in deep ocean sediments is too risky an undertaking.

- Insufficient attention was given to the viability of transmutation technology.

Some commenters expressed the view that what the U.S. Government undertakes today in the management and disposal of wastes should not prejudice or preclude subsequent adoption of alternative technologies. This view would defer committing to mined repositories until (1) all of the criteria, standards, and regulations for health and safety and other environmental parameters are in place; and (2) R&D on longer term alternatives is completed so that the U.S. Government can make an informed choice on all of the technological options available to it rather than proceeding with the only means available in the near term. Moreover, since nuclear wastes are currently being managed, although not disposed, in a way which protects health and safety, through surface storage measures and because surface storage for a finite period of time for technical and environmental reasons is required to cool the wastes before ultimate disposal, the U.S. Government should defer proceeding rapidly to adopt a technology which possibly forecloses other options.

In addition the IRG was criticized for not having examined surface storage, especially dry surface storage.

IRG Response:

The IRG has reviewed its judgments about when implementation might be able to begin for the various technology options and still feels that the statements in the draft IRG report are appropriate. The IRG agrees the technical options other than mined repositories might one day become the preferred approach for high level and transuranic waste disposal, but still considers the relative near-term emphasis to be placed on each should be as described within the interim strategic planning basis for high level waste.

The IRG believes that steady progress towards actual disposal of nuclear waste is the proper approach as opposed to long-term interim storage because of its belief that future generations should not be saddled with a growing inventory of existing wastes generated from activities from which they have received no benefit.

The IRG considers interim surface storage of spent fuel at reactors or at away-from-reactor storage facilities to be important components of its overall approach to waste management until a repository is available. Surface storage should not, however, be viewed as in any way an alternative to ultimate disposal. Technology for interim surface storage in water pools is currently well in hand and some R&D effort is directed at dry storage.

STATUS OF KNOWLEDGE ON MINED REPOSITORIES

Because of the need to isolate High-Level Wastes and TRU wastes from the biosphere for relatively long periods of time, and because disposal in mined repositories is the nearest term option, the IRG carefully reviewed the present status of scientific and technological knoweldge pertinent to mined repositories. The IRG review identified a number of important technical findings which it believes to represent the views of a majority of informed technical experts.

- A systems approach should be used to select the geologic environment, repository site, and waste form. A systems approach recognizes that, over thousands of years, the fate of radionuclides in a repository will be determined by the natural geologic environment, by the physical and chemical properties of the medium chosen for waste emplacement, by the waste form itself and other engineered barriers. If carefully selected, these factors can and should provide multiple, and to some extent independent, natural and engineered barriers to the release of radionuclides to the biosphere.

- <u>Overall scientific and technological knowledge is adequate to proceed with region selection and site characterization, despite the limitations in our current knowledge and modeling capability</u>. Successful isolation of radioactive wastes from the biosphere appears technically feasible for periods of thousands of years provided that the systems view is utilized rigorously to evaluate the suitability of sites and designs, to minimize the influence of future human activities and to select a waste form that is compatible with its host rock. Beyond a few thousand years and during the period of time in which actinides and long-lived fission products remain toxic, our capability to predict and therefore our assurance of successful isolation diminishes. Some uncertainties can be bounded or compensated for and, therefore, need not be resolved completely before selecting a site or constructing a repository. In addition, some will be resolved during repository construction. Although some residual uncertainty will always remain, reliance on conservative engineering practices and multiple barriers can compensate for a lack of total knowledge and predictive capability.

- <u>Detailed studies of specific, potential repository sites in different geologic environments should begin immediately</u>. Generic studies of geologic media or risk assessment analyses of hypothetical sites, while useful for site selection, are not sufficient for some aspects of repository design or for site suitability determination. Detailed, time-consuming, site specific investigations are needed to determine the suitability of a particular site. The need to obtain access to specific potential repository sites is therefore urgent to assure the timely development of the first repository, and subsequently a series of repositories. Although most is known about the engineering aspects of a repository in salt, on purely technical grounds no particular geologic environment is an obvious preferred choice at this time. The system view implies that geologic environments and media heretofore not examined may be suitable for repository sites.

- <u>The actinide activity in TRU wastes and HLW suggest that both waste types present problems of comparable magnitude for the very long term (i.e., greater than a thousand years)</u>. Although TRU does not generate a significant amount of heat, and has lower levels of penetrating radiation and transuranics per unit of weight than HLW, the transuranic content of a TRU waste repository could be significant. Therefore, the waste form and the leach rate, groundwater flow rate, and retardation factors used in selecting TRU waste repositories should be considered as carefully as when choosing HLW repository sites and design.

- The degree of long-term isolation provided by a repository, viewed as a system, and the effects of changes in repository design, geology, climate, and human activities on the public health and safety can only be assessed through analytical modeling. Although work is needed to assure that all potential release mechanisms are considered, to improve modeling of groundwater flow through fractured media, and to evaluate or remove other uncertainties, bounding calculations can be performed in most instances so as to place reasonable limits on the expected behavior of a repository.

- The effects of future human activity must be evaluated more carefully. Relatively little attention has been devoted to the effects of future human activity on the repository or its hydrogeologic environment, or to the means available to the present generation for influencing such effects. Because it is not possible to predict or to restrict the activities of future generations, site selection guidelines, site suitability criteria, and repository design criteria must be developed in such a way as to minimize potentially deleterious effects of human activities.

Public Comment:

Numerous comments, of both a general and a specific nature, were received on the technical findings related to high level and transuranic waste disposal in mined repositories. Rather different and conflicting interpretations were made of some of these findings.

Those who believed the findings expressed a view that is too optimistic commented:

- The gaps in knowledge identified in Subgroup 1's Appendix A were not adequately reflected in the summary of the technical findings.

- The basis for attributing these findings to the majority of informed technical experts is not given. In fact technical opinion is divided.

- There is no more reason to have confidence in the IRG's findings than in similar previous statements by the National Academy of Sciences and other scientific bodies which over time have been shown to be inadequate.

- The findings were inconsistent with the more pessimistic reports of the GAO, EPA, USGS, and California Energy Commission.

Those who saw the findings as expressing a view that is too pessimistic observed:

- The findings are more pessimistic than warranted by the discussion in Subgroup 1's Appendix A.
- More acknowledgment should be given to the past accomplishments of the R&D programs that have been addressing high level waste disposal.
- The IRG should explicitly take a position that the problem can be solved. Some commenters noted that in their opinion this view has already been expressed by the National Academy of Sciences and the American Physical Society.

In general the systems approach, addressed in the first technical finding, was endorsed. Some commenters, however, questioned the meaning of the concept and criticized it for being contentless, full of jargon, and vague. Other individuals felt that more emphasis should have been placed on the need for multiple barriers to hedge against uncertainty while still others observed that the barriers might not be truly independent and therefore not provide sufficient protection. Another group of individuals said that more credit should be given to engineered barriers than the Draft Report does.

The second technical finding was widely regarded as the most important and was variously interpreted by different commenters to mean that the IRG concludes that:

- technology now exists to dispose safely of high level and transuranic wastes in mined repositories;
- insufficient information and expertise currently exist to be able to determine whether or not a site, once characterized, is suitable for a waste repository;
- much more work needs to be done before the technology is available to dispose safely of high level and transuranic waste

Most commenters agreed with their particular interpretation of the statement, although some disagreed with the statement as they interpreted it.

Some commenters interpreted the statement about salt in the third technical finding to mean that salt is an adequate host rock. Others argued that because most is known about the engineering aspects of a repository in salt, it is obviously preferred at this time. Others said that for a variety of reasons, most of which were identified in the

Appendix A of the Subgroup 1 Draft Report, salt is not a suitable host rock. Several commenters stated that sites should not be investigated until EPA's general environmental criteria for repositories and/or NRC's standards are available.

Several commenters stated that the fourth technical finding does not take sufficient account of the difference in heat content and transuranic element content of TRU waste compared to high level waste, particularly if spent fuel rods are disposed of.

Several people commented that the modeling efforts mentioned in the fifth technical finding were not likely to be fruitful or valid and that bounding calculations could be quite inaccurate. Others said that the IRG seems overly willing to rely on the results of model calculations. Still others noted that modeling skills will improve in the future and therefore current deficiencies are not cause for delay.

The point was raised in connection with the sixth technical finding that more attention also needs to be given to human and man caused changes in the environment, such as changes in rainfall patterns that could result from CO_2 buildup in the atmosphere.

Some commenters criticized the IRG for not having addressed the biological implications of radiation releases to the biosphere; and for not considering the possibility that our current understanding of this subject might underestimate the impacts.

IRG Response:

The basis for the technical findings was the Appendix A of the Draft Report of Subgroup 1 on Alternative Technology Strategies, TID-28818 (Draft). As stated in the Preface of that Appendix, several earlier drafts were widely distributed within the interested scientific and technical community. Hundreds of written and oral comments were received and were taken into account in producing the draft contained as Appendix A of the Draft Subgroup I Report. This effort is the basis for the IRG's statement that it believes its technical findings to represent the views of a majority of informed technical experts. This document will be further revised as necessary on the basis of comments received subsequent to its publication and will be republished in final form. The IRG, of course, recognizes that a wide range of view on some points exist within the scientific and technical community. It also concurs that the possibility of failure of sites to qualify for licensing, of course, exists, and that the public must be aware of such possibilities. The second technical finding, as revised and presented below, now addresses this possibility.

On setting forth its principal technical findings and conclusions concerning disposal in mined repositories, the IRG intended to describe the status of scientific and technical knowledge relevant to mined repositories and to draw only those technical conclusions which are warranted on the bases of that knowledge.

The IRG recognizes that the term "system approach" can be misunderstood. However, it believes that the use of this term in reference to mined repository, is now widely understood within the technical community and is quite useful. The IRG supports its continued use. The IRG also continues to endorse its statements contained in the first technical finding on the important subjects of multiple barriers and engineered barriers.

The IRG agrees that the second technical finding is particularly important and that as stated it can be interpreted to have quite different meaning. The IRG now wishes to restate the finding as follows:

Present scientific and technological knowledge is adequate to identify potential repository sites for further investigation. No scientific or technical reason is known that would prevent identifying a site that is suitable for a repository provided that the systems view is utilized rigorously to evaluate the suitability of sites and designs, and in minimizing the influence of future human activities. A suitable site is one at which a repository would meet predetermined criteria and which would provide a high degree of assurance that radioactive waste can be successfully isolated from the biosphere for periods of thousands of years. For periods beyond a few thousand years, our capability to assess the performance of the repository diminishes and the degree of assurance is therefore reduced. The feasibility of safely disposing of high level waste in mined repositories can only be assessed on the basis of specific investigations at and determinations of suitability of particular sites. Information obtained at each successive step of site selection and repository development will permit reevaluation of risks, uncertainties, and the ability of the site and repository to meet regulatory standards. Such re-evaluations would lead either to abandonment of the site or a decision to proceed to the next step. Reliance on conservative engineering practices and multiple independent barriers can reduce some risks and compensate for some uncertainties. However, even at the time of decomissioning some uncertainty about repository performance will still exist. Thus, in addition to technical evaluation, a societal judgment that considers the level of risk and the associated uncertainty will be necessary.

While agreeing with the above revision of the second technical finding, some members of the IRG are still concerned that insufficient attention is given in this report to significant gaps and uncertainties in our current technical understanding. The scientific feasibility of the mined repository concept remains to be established. The preferred approach to long-term nuclear waste disposal may prove difficult to implement in practice and may involve residual risks for future generations which may be significant.

The IRG does not wish to endorse or criticize any particular potential host rock. Application of the systems approach to repository site selection and design implies that the suitability of any potential repository site depends on the geologic hydrologic, geochemical and engineering factors, including waste form, that comprise the total repository system. The properties of the host rock are important relevant factors but need not be the most important. Discussions of host rock suitability, independent of other factors, is therefore inappropriate and misleading.

The IRG recognizes the points raised concerning the differences in heat and transuranic element content. It still feels the statement made in the fourth technical finding is correct.

The IRG understands that model calculations, in this as in most other fields, have their intrinsic limitations. Nonetheless, if employed with sufficient care and adequate technical review, they have an important role to play in evaluating the risk of nuclear waste disposal in mined repositories. Indeed no other approach or risk assessment is available.

The IRG intended that the questions of human intrusion and man-induced changes in the environment (including the effects of CO_2 buildup) be included within the term "future human activity" employed in the sixth technical finding.

The IRG recognizes that the biologic implications of radiation released to the biosphere and the possibility that new information might alter our understanding of those implications are important subjects. They have been and continue to be studied in the scientific community and are currently being addressed within the government by the Department of Health, Education and Welfare and by EPA and NRC as part of their regulatory activities. However, rather than duplicate these other efforts and in order to address the issue of greatest current controversy, the IRG chose to focus its attention on the mechanisms by which radioactivity might be released to the biosphere from a repository rather than what would be the biologic effects of such releases. Some members of the IRG in retrospect now believe the latter should have been done.

Risk Assessment

The risks associated with the long-term isolation of radioactive wastes cannot be verified or disproved on the basis of operating experience, experimentation or prototype testing. Rather, the risks to public health and environmental quality can only be assessed through mathematical modeling. Such a situation is not unique to the assessment of risks from many materials considered hazardous to human health and the environment such as arsenic, pesticides, carbon dioxide and fluorocarbons. The scientific community agrees that substantial further effort on risk assessment [2] of radioactive wastes in

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2/ Risk assessment consists of failure-mode analysis, probability estimation, and consequence assessment. Failure-mode analysis, which is based largely on a combination of scientific reasoning, engineering, experience, and intuition, involves identifying events and sequences of events and processes that lead to the release of radioactive material into the biosphere. The probability of these events actually occurring is estimated, and the consequences, in terms of radiation doses or human health effects, of radioactive releases is quantified. Descriptions and results of a number of risk assessment studies are presented in Appendix F.

geologic repositories, including site-specific assessments, is essential to determine the degree of long term isolation provided and the effects of changes in repository design, geology, climate, and human activities. The level of risk that the population might be subjected to can only be determined by assessments performed at repository sites. This is a result of the natural variability of rock mass properties and geologic heterogeneties which preclude the transfer of basic earth science information, or assessments performed with such information, from one site to another.

Once a repository is filled with radioactive waste and sealed, radionuclides contained in the waste can be returned to the biosphere in only two credible ways: (1) by exposure of the rock mass that contains the radionuclides, either through exhumation through physical movement of this mass to the surface; or (2) by dissolution of the waste by groundwater and movement of the radionuclides with the groundwater to a river, lake, well, or other point of discharge at the surface.

Either natural processes or human activities could conceivably lead to exposure of the buried waste, but current analyses indicate that, if appropriate site criteria are applied, the probability of exposure occurring would be quite small. Thus, the most likely mechanism of transfer is through dissolution and transport by groundwater. After a repository is breached by circulating groundwater, several barriers [3/] should mitigate the consequences of the breachment: the waste form that contains the radionuclides, if sufficiently inert, will inhibit the release of radionuclides into the water; the groundwater flow rate and flow path, if very slow and long, respectively, would allow the radionuclides to decay, perhaps to innocuous levels, by the time the water reached the biosphere and would allow sorption of radionuclides by rocks which would retard their movement.

One worst case assumption commonly made in risk assessment is that at some postulated time after the repository is closed the radionuclides in the waste will be completely dissolved in circulating groundwater or that they will dissolve at some specific rate. The time required for groundwater to reach the biosphere is estimated by assuming that the radionuclides move through surrounding formations along specified paths to the surface. The results of such an assumption are:

- radiation doses well above natural background levels, if the release occurs soon after closure of the repository or if flow paths to surface water are short, and

- radiation doses below natural background levels for long flow paths and for releases that occur in the very distant future.

3/ Although the term barriers is frequently used in the literature, a more precise expression would be mechanisms that inhibit the dissolution of radionuclides and their transport to the biosphere.

Public Comment:

Some commenters disagreed with or felt uncomfortable with the statements that:

> "The risks associated with the long-term isolation of radioactive wastes cannot be verified or disproved on the basis of operating experience, experimentation, or prototype testing."

and

> "Some uncertainties can be bounded or compensated for and, therefore, need not be resolved completely."

A portion of these commenters argued that, taken together, these statements were a rationalization for moving ahead prematurely. In contrast, others felt that in fact more certainty could be obtained about the risk that the statements implied.

Several comments were received suggesting that the IRG's discussion of failure scenarios was inadequate. Some individuals maintained that

- o there were plausible scenarios that would present greater hazards than the commonly used worst case scenarios identified in the Draft Report;
- o the problem of glaciers was ignored; and
- o the impact of climatic change, perhaps including an increase in sea level was ignored.

Finally, the IRG was criticized for not making any judgment on the social acceptability of the risks involved:

- o either indirectly by comparison to risk associated with natural phenomena and/or other anthropogenic hazards;
- o or directly by comparison to some standard such as the risks associated with naturally occurring ore bodies.

IRG Response:

The risk assessments performed to date, some of which are summarized in Appendix F to the IRG Draft Report and some others of which are cited in Section 4 of Appendix A of the Draft Report of Subgroup 1 have, with few exceptions, been based on idealized repository characteristics and are subject to significant uncertainties. These have been useful to advance the state of the methodology and to provide insight into the magnitude of risk to be expected from repositories whose features approximate the assumptions in the model. The IRG would like to emphasize, however, that risk assessment computations are needed which are site specific in the origin of their data and in their application and only such assessments can truly apply to a specific site. Some uncertainties about the level of risk will always remain both because of the current state of the methodology of risk assessment and because of of its inherent limitations.

Uncertainties associated with risk assessment derive from lack of data, lack of experience, inability to identify all release mechanisms for radionuclides, the natural variability in physical properties of geologic media, and inability to predict long-term geologic and climatic processes and social evolution. All of these uncertainties are neither additive nor of equal significance. An important aspect of the research remaining to be done is to understand how each enters into the overall uncertainty of the calculation of risk.

Risk assessments can provide valuable information for assessing the generic feasibility of the technology, setting standards, and possibly, comparing alternative sites. The IRG believes that modeling and other risk analytical techniques should not be used uncritically and that, whenever practicable, tests and other experimental evidence should be employed. Care should particularly be taken to employ an adequate data base, properly qualify risk analysis results, identify uncertainties, and avoid misuse of the approach.

The IRG does not believe that it is its role to specify or imply what the appropriate social judgment of acceptable risk should be. Under current statutory authorities, this matter will be addressed through the EPA and NRC regulatory programs.

Technical Conservatism

Regardless of how minimal hypothesized adverse effects might be, the IRG finds that the Federal government should maintain a technically conservative approach in pursuing the development of mined repositories for high-level and TRU waste disposal. For example, the repository could be loaded initially with coller waste or at a lower heat generation per acre than design studies suggest is necessary. The waste-emplacement rate could be lower during early operation to permit observation of a small number of waste filled canisters. And the repository could be designed, constructed, and operated so the emplacement waste could be retried during an initial period of operation.[4/] The ability to retrieve emplaced waste acts as a hedge against unforeseen problems that could occur relatively soon after the wastes are emplaced and that might jeopardize the safe operation of the repository.

4/ Retrievability here and elsewhere in this document means sealing each room and passageway after it is filled to close pathways to the environment, but keeping open the main shaft to permit removal of waste, if necessary, at a cost and level of difficulty not significantly greater than that incurred in emplacing the waste in the first place.

Because the necessary isolation periods for waste disposal are so long, no demonstration can prove the presumption of safety. Thus, a social consensus, based on scientific evidence, must be obtained through:

- o Dissemination of fundamental scientific information
- o The development, analysis, and near-term validation of long-term predictive models
- o Extensive, independent, objective review of results by scientific experts, and of proposed facilities and operations through the licensing process
- o Practical experience, including careful monitoring of the isolation systems
- o A demonstrated capability to take any needed corrective or mitigating actions
- o An ongoing R&D program to increase the state-of-the-art of knowledge

Only if such a social consensus is obtained can disposal of HLW and TRU waste in geologic formations actually be implemented and the public be confident that nuclear waste can be safely isolated in this way over very long periods of time.

Because mined repositories appear to offer a viable near-term opportunity for disposal of both HLW and TRU waste, the IRG used this technology as a central element for considering various interim strategic planning bases for disposal of these waste types.

Public Comment:

Most commenters on this subject endorsed the notion of technical conservatism. Some suggested it could and should obviate the necessity of intermediate scale facilities. Others suggested that an even more conservative approach would be to keep spent fuel in surface storage, perhaps for several decades, until it had greatly cooled or until a decision with respect to reprocessing is made. The comment was also made that the only results of proceeding in a conservative manner would be to delay the full operation of a repository and continue to undermine public confidence.

Many industry and some other commenters urged that if spent fuel is placed in a repository, retrievability should be maintained to keep open the option of reprocessing. Some commenters were concerned that the IRG presented no information about the circumstances in which removing the waste might be desirable, whether it would be possible in such adverse circumstances, or how long retrievability could be maintained under optimum conditions. The IRG was urged not to impose arbitrary limits on how much it was willing to spend to maintain retrievability and to recognize that retrievability is meaningful only if facilities are available into which the waste could be transferred if retrieved.

For a summary of comments made on the IRG's discussion of the need for "social consensus," please refer to the section on public participation.

IRG Response:

The IRG wishes to reiterate its view that a repository should begin operations in a technically conservative manner. By this is meant that margins of safety should be included in such design and construction features as heat loading, monitoring ability and rates of loading. There is a relationship between this concept and the notion of intermediate scale facilities which is addressed in the section on that topic.

The IRG agrees that there is a trade off between the advantages of rapidly isolating the waste from the environment and those associated with retrievability. Further analysis is required and will be performed but currently the compromise expressed in the footnote on page 46 seems reasonable from a technical perspective as an interim design basis.

The IRG's retrievability approach is directed at technical conservatism and safety considerations, not future reprocessing. The IRG does not agree that any other function of retrievability in a repository is appropriate. Further, the cost estimate in that footnote was not intended as a limit on how much should be spent to retrieve waste, but rather just an estimate of what the cost would be to remove the waste should that prove necessary and if the procedure suggested were followed. Further technical work will be necessary to assure retrievability for reasonable time periods in particular geologic settings. In some instances special containers and packaging may be required. Assessment is also necessary of the circumstances in which removal of the waste would be desirable. The IRG agrees that for such removal to be possible, alternative facilities must be available. Surface facilities at the site will provide some capability and the opening of repositories earlier than absolutely necessary in order to implement the regionality concept would also provide back-up.

The discussion of technical conservatism in this section is limited to the application of this concept to the design, engineering and heat loading aspects of mined repositories. A broader application of this concept is contained in the later section on the IRG recommendations on the near term approach to HLW disposal.

INTERIM STRATEGIC PLANNING BASIS FOR HLW DISPOSAL

The choice of technical strategies for the disposal of HLW and its implementation must await completion of the appropriate Generic Environmental Impact Statement (GEIS) required by NEPA. However, because near-term waste management programs must be developed, priorities assigned and R&D activities planned prior to the completion of the NEPA process and selection of a strategy, a clear interim strategic planning basis must be set forth. It must be designed and executed in a way that does not prejudice the NEPA process. In particular, interim decisions must be of a nature that preserves options rather than forecloses them. It is unacceptable to conduct a NEPA review, the outcome of which has been largely predetermined or one that is carried out mainly to justify or ratify decisions already made.

This section is basically a reiteration of views previously presented in Chapter I of the Draft Report under the heading "Development of An Interim Strategic Planning Basis." Public comment and IRG response related to this matter are accordingly located at that earlier point in the document.

INITIAL DEFINITION OF TECHNICAL STRATEGIES

The IRG established a special subgroup to provide it with analysis of potential technical strategies for the disposal of HLW.5/ As an input to the IRG deliberations, the IRG Staff Subgroup on Alternative Technologies defined and evaluated four technical strategies for HLW disposal:

- Strategy I provides that only mined repositories would be considered and that only geological environments with salt as the emplacement media would be considered for the first several repositories. As a result of past focusing on salt, there is a large volume of information available. In addition, one body of opinion holds that salt is the best, or at least an acceptable, emplacement medium and that suitable sites can be found where salt is the host rock.

- Strategy II provides that, for the first few facilities, only mined repositories would be considered. A choice of site for the first repository would be made from among whatever types of environments have been adequately characterized at the time of choice. Because generic understanding of engineering features of a salt repository are most advanced, the first choice is expected to be made from environments based on salt geology. Sites from a wider range of geologic environments would be available for selection somewhat later.

5/ Details of this analysis are reported in draft in "Alternative Technology Strategies for the Isolation of Nuclear Wastes," prepared by Subgroup One of the IRG, October 19, 1978

- Strategy III provides that, for the first facility only mined repositories would be considered. However, three to five geological environments possessing a wide variety of emplacement media would be examined before a selection was made. Other technological options would be contenders as soon as they had been shown to be technologically sound and economically feasible.

- Strategy IV provides that the choice of technical options and, if appropriate, geological environment be made only after information about a number of environments and other technical options has been obtained.

These strategies were defined by the IRG Subgroup so as to illustrate particular characteristics of a range of possible strategic approaches. These were not intended to be a complete list of possible strategies or comprehensive descriptions of a strategic planning basis that might actually be adopted by the waste disposal program. For the latter purpose, they are are admittedly incomplete.

Two other significant matters must be included with any such complete description. These two additional considerations, which are discussed below, are (1) regional site selection and (2) the use of intermediate scale facilities.

Public Comment:

Some commenters argued that the ocean sediment disposal option should have received greater prominence in each of the four illustrative strategies of this section.

The statement of Strategy I would be more balanced, one commenter said, if the following sentence were added: "Others are of the opinion that salt is not an acceptable emplacement medium for a high level waste repository."

Some commenters were confused by the introduction of Strategies I through IV. Others by the absence of a discussion of their relationship to the proposed interim strategic planning basis for high level waste discussed later in this report, including the open question of whether to plan to select the first repository site from a limited or a broader choice of geologic environments.

Some commenters raised the question about what would constitute reasonable alternatives for examination to fulfill the requirements of NEPA. Adoption of the systems view, they indicated, implies that comparisons must be made of alternative sites. An approach which first narrows to a particular emplacement medium and then only considers sites where that medium would be the host rock is not consistent with a system view.

IRG Response:

The IRG views on ocean disposal presented in the draft Report were not dependent on the treatment of this subject in the initial alternative strategies.

The IRG accepts the suggested addition to the statement of Strategy I. The IRG wishes to reiterate that Strategies I through IV were defined by Subgroup I only to illustrate particular characteristics of a range of possible strategic approaches and have no further significance. The IRG's proposed interim strategic planning basis is consistent with Strategy III in its treatment of non-repository technology options and its expansion of the breadth of the R&D and site characterization programs. It added the notion of regional siting and included a role for intermediate scale facilities. The first option of the open issue would be consistent with Strategy II's approach to siting the first repository and the second option would be consistent with Strategy III's approach.

The IRG agrees that the systems view is site specific and recognizes the interaction between geologic environment, media, waste form and other barriers and engineering aspects of repository design. These are seen most clearly when specific sites and specific repository designs are viewed as an integrated system. The IRG agrees that within an overall program which is looking at several potential media and a variety of geologic environments, it is consistent with the systems view to use the potential host rock as an organizing principle to locate alternative sites. Other organizational approaches (e.g., geographic, hydrogeologic, geochemical, etc.) are also possible and some may prove, on balance, to be better than others. Each organizing principle has has certain benefits and certain liabilities.

Regional Site Selection

Although generic work on particular geological media is important, it is not a substitute for complete examination of specific sites. But site-specific investigation requires access to potential sites, and gaining access from states, even to characterize sites, has been a major problem. To resolve the problem, the IRG recommends approaching the affected states collectively rather than individually, as in the past. Such an approach would place the problem, and its solution, in a proper national perspective. (Details of such an approach are discussed in Chapter IV.)

Once specific sites are fully investigated, an approach must exist for selecting appropriate ones for repository siting. Currently, planning assumes the selection of a single national waste repository site which would conceivably accommodate all civilian--and defense--generated waste ready for disposa through the end of the century, even assuming an expanded nuclear power industry (see Appendix D). With this single-repository approach, the near-term construction and operating costs might be less. However, the need to transport waste from all over the United States to a single facility could add significantly to cost and would result in numerous political and other institutional problems during site selection and operation.

<u>An alternative approach, recommended by the IRG, is to construct several repositories sited on a regional basis insofar as technical considerations permit</u>. Although higher capital costs would be incurred at the outset and carrying charges would be greater, the repositories themselves (which need not be opened simultaneously) would eventually be needed if nuclear power use continued and if nongeologic disposal alternatives were long delayed or proved not particularly attractive or technically or economically infeasible. Furthermore, these extra costs would be balanced by a number of important advantages. Regional siting would reduce the transportation requirements and attendant risks, provide redundancy that would hedge against the possibility of operational difficulties causing unexpected repository shut-down, and could assist in repository siting by distributing the burden across more than one location. In addition, the early development of several repositories could permit gaining experience with various environments and emplacement media sooner than would be otherwise possible.

In applying this regional approach, there is a risk that organizational and political commitments might develop to particular regions or locations to such an extent that less than full attention would be given to safety, environmental and security considerations. Therefore, the DOE must be certain that technical adequacy is a prerequisite for site selection and must provide adequate assurance to the public in this regard.

<u>The IRG welcomes public comment on the adoption of this criteria for siting of waste disposal facilities</u>.

<u>Public Comment:</u>

Most of the many commenters on this subject endorsed the basic notion of siting repositories regionally insofar as technical considerations permit. However, many caveats were suggested. Some industry comments urged that the regional approach not be permitted to delay the opening of the first repository and stated that the first repository should be available for disposal of waste from all over the country until others are opened. Many concerns were expressed that the regional approach might result in an insufficient and less rigorous determination of technical suitability of sites and the IRG was urged to create safeguards to prevent that from happening. Some commenters argued that regional repository siting is unworkable because some regions of the country appear more favorable for the existence of suitable repository sites and other regions appear less favorable or unfavorable. The suggestion was made that regional siting might be appropriate for AFRs or low level burial sites, but not for repositories.

Some commenters argued that the regional approach would not be workable in the present political climate or that it would be too expensive. Others felt the notion was nothing more than a deception designed to win acceptance by states of repository siting within their borders. Still other commenters asserted that the case for the regional approach to repository siting had not been convincingly made. Some expressed skepticism that regional siting would reduce transportation requirements and risks or would provide useful redundancy.

The IRG was criticized for not having addressed explicitly the methodology to be used for site selection. Some commenters argued that the IRG should specify criteria for site selection or delay implementation of its recommendations until these criteria were available.

IRG Response:

The IRG's proposal to adopt regional siting insofar as technical considerations permit is not intended to suggest that the IRG believes that there will be an equivalent degree of technical difficulty in finding and validating suitable repository sites in all regions of the country. In fact the differences in regional geology might make some regions very good candidates and others very unlikely candidates. As stated in the draft report, the IRG is cognizant of the potential risk that, in applying the regional approach, organizational and political commitments might develop to particular regions or locations to such an extent that less than full attention might be given to safety, environmental and security considerations. The IRG wishes to emphasize, however, that the geologic, hydrologic, tectonic and other technical characteristics of sites must indeed remain the primary basis for site selection. The IRG believes this can be the case within the concept of regionality. The existence of environmental and licensing criteria established by EPA and NRC and the required NEPA reviews will and must act as safeguarding mechanisms to avoid any possibility that unacceptable sites might be chosen. The IRG's recommendation of a regional siting strategy is purposely and importantly qualified by "insofar as technical considerations permit."

The IRG does not believe that a regional siting strategy need delay the opening of the first repository. Indeed, just the opposite could be the case in that the regional approach may ease some institutional problems in the siting of the first and subsequent repositories.

The IRG agrees that analysis is required of possible transportation and redundancy advantages of the regional approach. Such analysis will be included in the environmental impact statement supporting the choice of high-level waste strategy in the GEIS.

The IRG found that enough technological knowledge exists at this stage to proceed with region selection and site characterization. Detailed studies to determine the suitability of specific potential repository sites for the various waste forms in different geologic environments should begin immediately because generic studies of various media are no longer an adequate basis for the program. However, gaining access to potential sites, especially those not on Federal lands, continues to be a major impediment to the waste management program. A number of potential sites in a variety of geologic environments should be identified, and near-term Federal actions should make enough of them available for characterization so that at least two (and possibly three) sites can survive characterization and the NEPA process and become operational within this century. Furthermore, to prevent intrusions by man (deep boreholes, mine shafts, etc.) that might preclude future considerations of areas for repositories, a number of potential sites in a variety of geologic environments should be identified within a few years and action should be taken to reserve the option to use them if needed at an appropriate future time. Under the regionality concept, these are intended to be located in different regions of the country. This concept also assumes state participation in planning, identifying, and characterizing geologic formations using the systems approach on a regional basis as well as participating in the planning and siting of facilities.

Several sets of criteria for site selection, evaluation, and qualification have been proposed. Some are rather general and some do not distinguish between criteria for site selection and criteria for site suitability.

Regardless of the existence of several proposed sets of criteria, those ultimately selected by NRC for evaluation and disqualification will prevail for licensing. NRC is currently drafting its regulations to provide only general guidelines; these will be supplemented by Regulatory Guides to provide more specific guidance in complying with the regulations and in meeting the standards to be set by EPA. At present, NRC is preparing separate guides for repositories in each rock type. Because the DOE is ready to select and characterize some sites now, the need for NRC guidelines is urgent. Until they are made final, DOE can proceed with its own tentative site suitability criteria or with the NRC draft criteria. In either instance, the possibility exists that the final NRC criteria might be different.

The IRG does not believe it appropriate to pre-empt or interfere with the responsibility of regulatory bodies to set site selection guidelines and site suitability criteria. The IRG does not believe that the absence of final guidelines and criteria need delay initial site investigation activities. However, the availability of objective site selection criteria necessary for licensing, and the licensing process itself are essential to and therefore must be a part of any final selection process for potential repository sites.

Intermediate Scale Facilities

The IRG believes that Intermediate Scale Facilities (ISF's) can play a distinct and desirable role in the transition from R&D to full-scale operational disposal facilities.

In this report the term intermediate scale facility applies to a facility in which some hundreds, perhaps as many as 1000 spent fuel assemblies or waste canister would be emplaced. In this case waste would be emplaced with the possibility of removing it if necessary, but without the expectation to do so.

"R&D facility" is used to mean a test with heaters or with small quantities where no more than some tens of spent fuel waste assemblies or waste canisters would be emplaced for a limited test period and then removed.

Either R&D or intermediate scale facilities could be built at the location of an early TRU waste repository, at the site of an expected high-level waste repository as part of the stepwise progression to full repository operations, or at a separate site dedicated only to the facility and at which there is no intention of ever building a full scale repository. Any intermediate scale facility would require licensing.

The functions of an ISF can be divided into (1) acquisition of technical, engineering, and operational data and (2) exercising and learning about licensing and organizational processes. Technical aspects of an intermediate scale facility would include improved understanding of engineering aspects of working in particular host rock and of near fields effects of the waste. The latter effects are those caused by waste-rock-fluid interactions and for which temperature differences, radiation, and nonequilibrium chemical reactions are relevant variables. By emplacing relatively few waste containers or fuel elements, some of this information would be obtained in a short time, perhaps five years. Much of it would apply generically to the type of host rock and the type of waste and packaging used.

Valuable information on intermediate field effects related to heat transfer and rock mechanics could be obtained by monitoring for perhaps 20 or more years. For this purpose, much larger heat loadings would be required than to learn about near field effects. Again, much useful information could be obtained about the particular rocks and environment surrounding the test and existing mathematical models could be tested. Such information could be used to verify and refine predictive capabilities that could then be applied to other sites with the same geologic medium for emplacement of the wastes.

An ISF would also provide valuable experience in constructing, operating and maintaining facilities and equipment for waste packaging, handling, transporting, emplacement and retrieval. For this purpose, the longer the facility operated, and the more waste that is emplaced, the more extensive would be the experience.

Exercising the licensing process for at least one ISF at an early date would be extremely useful preparation for the later licensing proceeding of the first full-scale repository. This would provide an actual proceeding on which the NRC, DOE, and interested intervenors could focus their attention and exercise their models, analyses, and arguments and from which everyone could learn about the nature of this complex process.

An ISF into which hundreds of spent fuel assemblies or waste canisters were placed and therefore of a size adequate to provide useful construction, operating, maintenance and organization experience would surely also be a candidate for licensing. A small facility, needed for urgent R&D purposes and from which the waste would certainly be removed following tests, would not have to be licensed.

Public Comment:

Most commenters on the ISF concept argued that little or no purpose would be served by an ISF that was built at a site known ahead of time to be unavailable for a full-scale repository. Rather, ISFs received most support as part of a stepwise progression toward a fully operating repository. Many commenters, however, did endorse the notion of a stand-alone ISF or an ISF colocated with a dedicated TRU repository. With respect to the colocation option, some concern was expressed that linking the ISF concept to the TRU repository in the WIPP proposal might jeopardize the ISF or the TRU repository. Some urged that a stand-alone or colocated ISF not be licensed or that the proposal to license was premature. Others said an ISF would not be needed in a salt host rock but would be very useful in other geologic media.

Many commenters asserted that the IRG had not adequately explained the ISF concept. In particular some said they were confused about the difference between an ISF as part of a stepwise approach and the initial period of repository operations when retrievability might be maintained.

Some commenters opposed ISFs altogether because they felt that their construction was premature until further R&D is completed or that nothing would be learned that could not be learned as well from the first repository. They also felt that their pursuit would only slow down the progress toward an operating repository. Some said ISFs should not be pursued if progress toward a full repository would be delayed. Some agreed that an early exercise of the licensing process would be useful but others did not.

Many commenters pointed to the close proximity of the earliest expected completion date of an ISF, 1986, and the earliest expected completion date of a full repository if the first of the two options identified were chosen. They pointed out that the site of the first repository would have to be chosen before the ISF were even operational and that after only two years of ISF operation, the full repository would be open. Yet five years is said to be approximate time required to learn about near field effects. The question was asked what value the ISF would have if insufficient time were allowed to derive benefit from it. Some commenters were led to conclude that the proposal for an ISF had no adequate technical basis.

Several commenters pointed out that in its role as a component of a proposed interim strategic planning basis for high level waste disposal, a proposal to pursue an ISF must be subject to examination through the NEPA process.

Several environmental and consumer groups argued that even small R&D facilities should be licensed because some potential hazards will be associated with the site and the transport of waste to it, because there may be considerable incentive to expand an R&D facility into a full-scale repository and because the retrievability promised as an element of the R&D facility may turn out not to be feasible. Several commenters also disagreed that urgency exists with respect to the need for small R&D facilities.

IRG Response:

The IRG agrees that the statements about ISFs in the draft Report are confusing. In light of the public comment on the subject and the IRG's further consideration of the matter, the IRG wishes to both clarify and restate its views.

The IRG agrees that the notion of an ISF as part of the stepwise progression to full repository operations is essentially the same as the retrievable phase of the repository. To avoid further confusion, the IRG now proposes to use the term ISF only for stand-alone facilities or those colocated with a TRU repository and use the term "the retrievable phase of the repository" to include the notion of adequate instrumentation for purposes of studying the behavior of waste and the waste rock interactions during the interval for which retrievability is possible.

As indicated in the Draft IRG Report, only some of the technical information about geology and waste-rock interactions derived from an ISF could be transferred usefully to another site. However, most of whatever institutional information that is acquired (including operational experience, logistics, organizational design and licensing) could be transferred. As stated in Chapter IV of the draft IRG report, the IRG considers the resolution of institutional issues to be equally as important as for technical ones. In addition, much of the institutional information will come before and during the construction of an ISF or as it begins operations. This information can be very beneficial to many aspects of the program directed at opening the first fullscale repository. Some of the technical information, if available at the time of repository site selection, could also be utilized, in site selection, but it is by no means essential for that purpose.

The IRG believes that an ISF is not an essential component of a program leading to a full-scale repository. All of the institutional knowledge obtainable from an ISF could also be obtained in the selection, licensing, and construction of the first repository and during its early period of operations. There would therefore be no value in delaying the pace of the program leading to the first repository just to build and operate an ISF.

An ISF is not an essential component of a program leading to a full-scale repository. Nonetheless, if an appropriate opportunity to build an ISF on a schedule significantly prior to the opening of the first full-scale, high-level waste repository were to exist, the opportunity should be taken. From a purely technical perspective, an appropriate opportunity implies technical readiness and the completion of an adequate site characterization program. However, other non-technical factors should also be taken into account. Some agencies believe that an adequate site characterization program must include characterization of a variety of sites, indifferent geologic environments, and relying on diverse media. All ISF's should be licensed, since these elements will be an important step in the ultimate location and construction of repositories to acquire institutional experience and to protect public health and safety.

Some members of the IRG believe that an ISF should only be sited at a location where the possibility of placing a full-scale, high-level waste repository is recognized from the beginning. Therefore,the criteria, standards and procedures (including appropriate state and local government and public involvement) governing the site selection process for a possible expanded application must be rigorously observed from the initial steps of ISF siting.

The 1986 date, suggested as the earliest possible operation of an ISF, corresponds to the possibility of building an ISF at the proposed site for the WIPP facility near Carlsbad, New Mexico, assuming no slippage in the current planning schedule. The uncertainty of this date is large. An ISF at any other site would be in operation somewhat later.

Some members of the IRG believe, however, that an ISF should not be co-located with a dedicated TRU repository, but rather that the TRU and HLW activities should proceed at different locations.

The IRG wishes to reiterate that an ISF would be a licensed facility--indeed much of its purpose would be to exercise the licensing process.

Some members of the IRG do not feel that small R&D facilities, from which emplaced waste would be retrieved upon completion of the tests, need to be licensed. Experience exists in removing small quantities of waste after only a few years emplacement. Transportation of the waste to and from the facility would be regulated in the usual manner. Some members of the IRG believe that a decision on whether R&D facilities should be licensed should be made by NRC on a case-by-case basis based on an assessment of risk to public health and safety.

IRG Recommendations on Near Team Approach to HLW Disposal

Upon consideration of the work of the IRG Staff Subgroup on Alternative Technologies and the additional considerations concerning regionality and ISF's presented above, the IRG took this work, developed further consideration of its own, and recommends the folliwing key characteristics of a near-term interim strategic planning base for HLW disposal:

- o Near-term program activities should be predicated on the tentative assumption made for interim planning purposes that the first disposal facilities for HLW will be mined repositories. Several geological environments possessing a wide variety of emplacement media will be examined. Once the NEPA process has been completed, program activities can be tailored accordingly.

- o Near-term R&D and site characterization programs should be designed so that at the earliest date feasible, sites selected for location of a repository can be chosen from among a set with a variety of potential host rock and geohydrological characteristics.6/ To accomplish this, R&D on several potential emplacement media and site characterization work on a variety of geologic environments should be promptly increased.

- o With respect to R&D on technical options other than mined repositories, the nearer term approaches (i.e., deep ocean sediments and very deep holes) should be given funding support so that they may be adequately evaluated as potential competitors; funding for rock melting, space disposal and transmutation would allow some feasibility and design work to proceed.

- o A number of potential sites in a variety of geologic environments should be identified and early action should be taken to reserve the option to use them if needed at an appropriate future time. Near-term actions should create the option to have at least two (and possibly three) repositories become operational within this century, ideally, in different regions of the country.

- o Initial emplacement of waste in at least the first repository should be planned to proceed on a technically conservative basis and permit retrievability of the wastes for some initial period of time.

As part of this near-term interim strategic planning basis for HLW disposal, the IRG also recommends that:

- o Work should proceed promptly to permit siting of one or more intermediate scale facilities (ISF's) in different emplacement media and geologic environments. All ISF's should be licensed since these elements will be an important step in the ultimate location and construction of repositories to acquire institutional experience and to protect public health and safety.

The earliest possible date at which such a licensed ISF could be in operation is estimated to be 1986.

6/ The earliest date for operation of a licensed repository, whose site was selected by this process, and using an idealized schedule, would be 1992; actual operation, recognizing reasonable possible deviations from the ideal, could be up to 3 years later.

The IRG particularly welcomes public comment on the use of intermediate facilities in the transition from R&D to full-scale operational disposal facilities.

The IRG has considered, but not formulated an opinion at this stage of its review, whether the interim strategic planning basis for the first repository should presume, pending decisions taken through the NEPA process, either:

- o that near-term programs would plan for an earlier choice of a first repository site from a set of potential sites covering a limited range of geologic environments; or
- o that near-term programs would assume that the choice of the first repository site will await the availability of a set of potential sites covering a broader range of geologic environments.

In the latter case, the choice of site could not be made before 1984 and construction of the first repository could be completed at the earliest by 1992; prudent planning suggests anticipating initial operation during the period 1992 to 1995. In the former case, a choice might be made from among sites that rely on salt as the emplacement media as early as 1980 since generic understanding of engineering features of a salt repository are most advanced. Construction of the first repository could be completed as early as 1988; prudent planning suggests anticipating initial operation during the period 1988 to 1992.

Siting and construction of a repository at an early date could indicate progress in safe management of wastes and increase knowledge most rapidly. This approach would, however, involve higher near-term costs and run increased risk of both technical and institutional failure which could be detrimental to the overall program. Moreover, by focusing the program at this point on near-term options (principally salt repositories), this approach risks prejudicing the NEPA review by tending to foreclose options prematurely. Since there are balancing considerations involved, further evaluation is required before a decision can be made on this element of the interim strategic planning basis.

Public comment on this question will be particularly welcomed.

Public Comment:

Public comment on technical conservatism, retrievability, regional siting strategy, ISFs and the appropriate role of the varous technical options have been noted above. Most commenters on the elements of the proposed interim strategic planning basis agreed with them. Virtually all comments on the degree of diversity of the base program endorsed the IRG's proposal for further diversity. Some who argued that we know enough to proceed in salt now perhaps meant to imply that diversification was unnecessary, but this was rarely stated explicitly. Many commenters, particularly those from industry, stressed the need for urgency in opening the first repository. Some said that the country should be prepared to accept interim solutions now, with the expectation that improvements will be made later. Some environmental groups and others preferred an interim strategic planning basis modeled after Strategy IV. A few commenters argued that the non-repository options were not worthy of funding. Some others were critical of the concentration of effort on mined repositories.

Numerous commenters favored one or the other of the two options identified as a possible interim strategic planning basis for the first repository. Some environmental groups favored a third option consistent with Strategy IV. Almost all commenters from industry preferred the option that would select the first repository site from a limited range of geologic environments and all environmental groups not preferring Strategy IV favored the option that would choose from a broader range of geologic environments. A few supporters of Option 1 qualified their support to be only if the early repository were not in salt or only if the first repository were preceded by an ISF.

Some commenters criticized the dates associated with each of the two options as being too optimistic. Others argued that the schedule should be accelerated. Some urged that the government not identify arbitrary dates for repository opening, but just move as fast as possible. Others were critical of the absence of a more detailed schedule.

IRG Response:

Upon further reflection, the IRG has now expanded and further clarified its views on the interim strategic planning basis for HLW and would restate the elements of this strategic basis as follows:

- The approach to permanent disposal of nuclear waste should proceed on a stepwise basis in a technically conservative manner.

- After having examined the status of knowledge relevant to disposal in mined repositories and by such other technical options as placement in deep ocean sediments, placement in very deep drill holes, placement in a mined cavity in a manner that leads to rock melting, partitioning of reprocessing waste and transmutation of transuranic elements, and ejection into space, we conclude that near-term program activities should be predicated on the tentative assumption made for interim planning purposes that the first disposal facilities will be mined repositories. The nearer term alternative approaches (i.e., deep ocean sediments and very deep holes) should be given funding support so that they may be adequately evaluated as potential competitors. Funding of other concepts should allow some feasibility and preliminary design work to proceed. Once the NEPA process has been completed, program activities can be tailored accordingly.

- Near-term R&D and site characterization programs should be designed so that at the earliest date feasible, sites selected for location of a repository can be chosen from among a set with a variety of potential host rock and geohydrological characteristics. To accomplish this, R&D on several potential emplacement media and site characterization work on a variety of geologic environments should be increased promptly.

- A number of potential sites in a variety of geologic environments should be identified and early action should be taken to reserve the option to use them if needed at an appropriate time. In order to avoid working toward and ultimately having a single national repository, near-term options should create the option to have at least two (and possibly three) repositories become operational within this century, ideally and insofar as technical and other considerations permit, in different regions of the country. In pursuing a regional approach to siting, geologic, hydrologic, tectonic and other technical characteristics of sites and safety considerations must remain the primary basis for selection.

- Construction and operation of a repository should proceed on a stepwise basis and initial emplacement of waste in at least the first repository should be planned to proceed on a technically conservative basis and permit retrievability of the waste for some initial period of time. Further definition of the retrievability concept, the circumstances in which waste would be retrieved and the technical aspects (including development of waste packaging, containers and handling, is necessary.

- Interim storage of spent fuel is required during the period of time before disposal facilities are available and will reduce the heat burden for disposal. To the maximum extent possible, utilities should keep their spent fuel at reactors until a repository is available. However, some quantity of spent fuel will have to move to away-from-reactor storage. In order to assist in providing flexibility to the program for selecting repository sites and bringing repositories into operation, the Federal government should provide storage capacity as needed for limited quantities of spent fuel. All costs of storage and disposal should be paid by the utilities.

- An ISF is not an essential component of a program leading to a full-scale repository. Nonetheless, if an appropriate opportunity to build an ISF on a schedule significantly prior to the opening of the first full-scale, high-level waste repository, were to exist, the opportunity should be taken. From a purely technical perspective, an appropriate opportunity implies technical readiness and the completion of an adequate site characterization program. However, other non-technical factors should also be taken into account. Some agencies believe that an adequate site characterization program must include characterization of a variety of sites, in different gelogic environments and relying on diverse media. All ISF's should be licensed, since these elements will be an important step in the ultimate location and construction of repositories to acquire institutional experience and to protect public health public health and safety.

All IRG members agree with the above elements of the recommended interim strategic planning base for high-level waste. The elements

- do not prejudge the NEPA process
- require the Federal government to maintain a teohnically conservative approach
- call for resolution of uncertainties by increasing the technical and program breadth with respect to the near-term repository characterization program
- do not preclude subsequent adoption of longer term technologies inasmuch as they call for increased R&D to develop selected alternatives
- support a step-wise approach to the development of a HLW repository, while maintaining storage capacity for managing wastes until emplacement and disposal opportunities are available

With respect to the basis for selection of the first HLW repository site, the IRG is still considering this matter.

With respect to the range of dates for possible repository opening, the IRG notes that these estimates do not reflect the possibility of political or unforseen technical difficulties, the impact of which cannot reasonably be estimated. Some members of the IRG believe that these additional uncertainties actually cause the range of estimated dates of opening the first repository in two cases.

Alternative Proposals

Public Comment:

Comments were received advocating that more attention be given to funding and developing ways in which nuclear waste could be put to use, rather than concerning ourselves with disposal and isolation. For example, one commenter emphasized using the heat generated by the radioactive decay process for space heating and process steam. Another commenter advocated pursuit of retrievable storage so that the isotopes present in the wastes can be reclaimed for beneficial uses as these are discovered and developed.

Some commenters proposed an experimentation program to fill major knowledge gap, which they felt currently prevented the development of a high enough level of understanding to establish the feasibility of the geologic disposal concept. Their concerns covered hydrology, especially on flow thru rocks with low permeability; waste rock interactions, that is the thermal, physical, and chemical effects of waste on host rock and mutual interactions; radionuclide sorption by surrounding materials; and shaft and borehole sealing.

Specifically, the proposal was to establish a series of vault tests designed to achieve equilibrium conditions which would provide information on fluid flow through factured rock, rock thermal, mechanical and compositional response, and the geochemical retardation of radionulcides moving in solution. After normal test conditions, some experiments should be run to failure, that is overloaded, not to simulate possible future conditions but rather to show that the observed response can be predicted accurately. Suggested vault tests would be run in two different media and at a minimum of two sites per medium. Water would be added to the formation to simulate the effects of flooding. Waste canisters would be emplaced on a small scale with a firm commitment of retrieval.

Vault testing was suggested to be superior to the ISF proposal of the IRG. The first ISF facility is projected to become operational in 1986 which is too late to be of use in providing fundamental scientific data, especially from those tests that require several years to complete. The ISF's will provide repository preoperational and operational information, but the major uncertainties affecting safety relate to postoperational behavior.

Finally, it was suggested that the Vault approach would be more effective in obtaining public confidence, would "demonstrate" the scientific feasibility of the geologic disposal concept, would test the multiple barriers and more appropriately meet regulatory criteria.

IRG Response:

Aside from the possible use of discarded spent fuel as a heat source, other beneficial uses would require reprocessing and are therefore contingent on a decision to initiate reprocessing in the future. R&D efforts addressing a variety of potential beneficial uses of components of reactor wastes are being pursued.

The IRG agrees that additional experiments will need to be conducted to gain information on such matters as the flow through rocks with low permeability and interactions between waste forms and specific potential host rocks. Many elements called for in the proposed series of vault tests are to be conducted in the proposed work plans of DOE. Data on rock mechanics, for example, are presently being obtained in two separate experiments using electrical heaters in granite formations. Similarly, data on waste rock interactions are being obtained or experiments are planned.

Many other of the tests called for can be conducted in planned R&D facilities and an ISF if one were built. For example, thermal experiments at above design heating levels and temperatures could be conducted in an experimental area that would accompany any dedicated TRU repository or ISF. Still other tests can be accomplished in an ISF. Information to validate models will be available well before a commitment is made to give up the option to retrieve waste already emplaced in an ISF or a future repository.

Achievement of equilibrium or steady state conditions for test purposes is possible only for certain effects and this can be achieved best at the location of an actual repository during its retrievable phase. A requirement to test the other long-term effects prior to repository operations is unrealistic and could imply indefinite postponement of waste disposal.

Testing to failure may not be appropriate or necessary because:

- such a test would disqualify the test site but little of the information learned would be transferable to other sites;
- most information of interest from such a test is of a long-term nature and would thus be unavailable for many hundreds to a thousand years;
- useful information can be obtained on when failure could occur well before failure conditions are reached; and
- engineering and geologic sciences are thought capable of developing models that can provide adequate assessment of risk without having conducted tests to failure and gathered the resulting data.

Evaluation of the Recommended Approach

The IRG, in arriving at the above recommendations on key characteristics of an appropriate strategic planning basis for HLW disposal, also evaluated its approach in terms of how well it met a vareity of objectives. These include the likelihood of:

1. assuring technical success,

2. satisfying NEPA and regulatory requirements,

3. achieving public confidence and credibility,

4. reducing time-dependent consequences,

5. dealing with diverse nuclear futures, and

6. supporting international objectives.

All of these matters are, of course, highly judgmental. The following brief discussion is admittedly incomplete and attempts only to highlight some of the more significant points.[7/]

Assuring Technical Success

Disposing of nuclear wastes in mined repositories is a highly promising approach to long-term isolation. While there is a possibility that such a technique could not be successfully employed, there is a high degree of confidence that a repository can be sited, designed, and operated so as to provide reasonable assurance of long-term isolation of radionuclides. For this reason, a program that assumes reliance only on mined repositories for the first few disposal facilities has a high probability of technical success.

A wide variety of geologic environments and emplacement media could be potential candidates for repository siting. Although most is currently known about the engineering aspects of a repository in salt, no particular environment is an obvious preferred choice at this time. A determination of adequacy can only be made for a particular site on the basis of extensive site evaluation. The expansion of the R&D in several potential emplacement media and of site characterization work on a variety of geologic environments will assure the possibility of choice from a diverse set of potential sites and provide back-up alternatives if one site, medium, or type of environment turns out to be unsuitable.

7/ More detailed discussion and analysis of each of these subject areas is included in the previous referenced IRG Subgroup One draft report.

Satisfying NEPA Requirements

The broad R&D program and implementation approach adopted within the proposed strategic planning basis is consistent with the obligation not to prejudice choices that must be made following NEPA review and provides substantial flexibility to deal with regulatory uncertainties.

Achieving Public Confidence and Credibility

The task of the waste disposal program is to understand the extent of the risk of various disposal alternatives and to choose one for which the risk is acceptably small. Broadening the range of alternatives examined provides for greater opportunity to find a lower risk approach. A related source of concern focuses on the issue of how adaptable a strategy is to new information and circumstances. Once again, strategies which provide diversity and redunancy allow modifications and alternatives to be made relatively easily. The recommended approach is consistent with this view.

Reducing Time-Dependent Consequences

Time-dependent consequences arise because the current inventory of nuclear wastes, as well as some fraction of those still to be produced, will have to be held in interim storage until a waste disposal facility begins to operate. The technology is available to store both military and commercial waste in an interim manner without endangering the public's health and safety. The likely cumulative dose exposure of storing all the spent fuel likely to be discharged from reactors by the year 2000 is a very small fraction (less than one percent) of the total dose exposure expected to be produced by the LWR fuel cycle. The cost of maintaining military waste at DOE defense sites in an interim manner is only a small fraction of the total estimated cost of preparing that material for final disposal in a geologic repository. The costs of maintaining commercial waste in interim storage is only a small fraction (less than one percent) of the cost of generating the power which produces the waste. As the period of time before a repository opens lengthens, logistical stresses will become potentially more acute. None, however, is insurmountable, at least in theory. Given these conclusions that time-dependent consequences do not presently represent a large source of concern or involve concerns that are unmanageable, the recommended approach provides a reasonable balance between the objective to move expeditiously toward disposal of existing and future HLW and a desire to obtain technical assurance that the waste will be disposed of safely.

Public Comment:

Several commenters disagreed that the time-dependent consequences of delaying the opening of a repository are small. Some argued that the political and pyschological costs would be high if the opening of a repository were long delayed. Still others claimed that the delay in opening a repository could impact adversely on the ability of commercial nuclear power to meet the country's electricity needs and that the economic and financial cost of using fossil fuels instead, would be very high.

IRG Response:

The IRG believes that adequate fuel storage can be provided pending repository availability and that such storage can be done safely with sufficient precautions.

Dealing with Diverse Nuclear Futures

Geologic repositories will be designed to recieve (1) defense HLW that is the product of reprocessing of defense fuels and/or (2) commercial HLW, either as discarded spent fuel or as solidified reprocessing waste. Thus, resolution of questions concerning future commercial reprocessing are not required in order to proceed with safe waste disposal. The recommended approach presumes the continuing need for repositories through time. The actual future need could be reduced by slow or no growth of nuclear power use. In such a case, however, the reserved repository sites would simply not be used and could be released for other purposes. For those reasons the IRG believes that the recommended approach is consistent with diverse nuclear futures and does not prejudge the outcome of a variety of nuclear issues still requiring resolution.

Supporting International Objectives

While it is difficult to predict what impact any particular strategic planning basis for the United States waste disposal program would have on other countries, it is fair to say that a strategy perceived as indecisive would almost certainly reduce our influence on achieving overall nonproliferation objectives at the international level. This is important to the United States because of our concern about possible proliferation consequences of nuclear power, our need to influence other countries with regard to the feasibility of permanent disposal of spent fuel, and our desire to protect the global environment by working with other countries to devise acceptable approaches to spent fuel management and waste disposal. ("For example, by offering to accept a limited amount of foreign spent fuel in the near term when this serves our nonproliferation interests.") The IRG believes that the recommended approach rests on sound technical grounds, represents a serious effort to deal effectively with the waste management problem, and that it should effectively support our international nonproliferation objectives.

Public Comment:

Some commenters criticized the IRG for not taking account of the discussions of waste management and reprocessing within the International Nuclear Fuel Cycle Evaluation (INFCE).

IRG Response:

The IRG agrees that recognition should have been given to the important discussion underway in INFCE. Although the final INFCE report will not be available until early 1980, the IRG is not aware of any matters that would lead to alteration of the findings and recommendations of this report. However, in any event, considerations flowing from INFCE which are of significance to strategic decisions will be available when these decisions are to be made in final form.

TECHNICAL STRATEGIES FOR DISPOSAL OF TRU WASTE

As with choosing a strategy for HLW disposal, the choice of a TRU waste disposal strategy must await completion of an appropriate environmental impact statement and its adoption through the NEPA process. In the meantime, Federal actions regarding the management of TRU waste must not prejudice the choice of strategies for their disposal. Nevertheless, an interim strategic planning basis will be necessary to guide the TRU waste managment programs and R&D activities before that choice is made.

In laying out the following technical strategies for TRU waste disposal, the IRG assumed that all TRU waste, whether generated by commercial or defense operations would be disposed of in the same manner because no technical reason exists to treat them differently. The two strategies examined by the IRG are:

> Strategy 1. No special action would be taken to pursue TRU waste disposal prior to the opening of a high-level waste repository. TRU waste would be disposed of in high-level waste repositories whenever they become available.
>
> Strategy 2. If an opportunity can be found, the program would proceed with an early dedicated TRU repository as soon as a site could be appropriately qualified and NEPA requirements fulfilled.

Enough TRU waste now exists, stored above ground, to warrant the opening of a repository dedicated to TRU. Such a facility could probably hold all the TRU waste to be generated through the end of this century. Of course, once a high-level waste repository were available, decisions on the location for disposal of then existing TRU wastes could be made on a case by case basis to maximize convenience and minimize transportation. A second repository dedicated to TRU waste alone would seem to be unnecessary.

Because of the presence in TRU waste of substantial quantities of transuranic radionuclides, issues related to long-term containment (such as the potential for groundwater transport, any possibilities of repository breachment, and concerns about mineral resources or tectonism) are identical for TRU and HLW repositories. However, the problems associated with heat generation and increase in temperature are absent and the TRU wastes are not as difficult to handle as HLW. The operational demands on a disposal system designed for TRU waste alone would be more modest than those associated with a HLW repository. In addition because of the absence of heat-related considerations, the regulatory review of a dedicated TRU repository would be somewhat simplified compared with that for a HLW repository.

Proceeding with an early, dedicated TRU repository would therefore be consistent with the previously recommended philosophy of conservation and proceeding stepwise into the most difficult disposal problem and would signal the government's determination to proceed in a timely manner with disposal of nuclear wastes. There would, of course, be some additional costs associated with the opening of a dedicated TRU facility.

Having considered these various matters, the IRG recommends adopting, as an interim strategic planning basis pending NEPA review, the concept of proceeding with an early TRU repository if an opportunity exists to do so. Whether or not this concept can be implemented in fact will depend on matters such as determination of site availability and suitability, NEPA evaluations and regulatory decisions which will occur in the future and cannot now be predetermined as well as decisions whether to exhume or to leave in place existing TRU wastes.

The implementation of this recommendation could conceivably be by means of the Waste Isolation Pilot Plant (WIPP) program, now underway at the Department of Energy. WIPP is a conceptual facility for which detailed engineering specifications have yet to be formulated. It is currently intended for ultimate geologic disposal of TRU wastes from the defense program and as a facility in which to perform R&D in salt with other waste material.

The Department of Energy has for some time been examining a site near Carlsbad, New Mexico as a possible location for the WIPP facility. The site evaluation report and the Environmental Impact Statement relevant to this site have not yet been completed but publication for public review and comment is expected shortly. In the absence of these documents neither the Department of Energy nor the Interagency Review Group are in a position to form a judgment about the adequacy of this site. This judgment will be made through the NEPA process at a later date.

Public Comment:

Fewer commenters addressed the TRU interim strategic planning basis than addressed the high level waste interim strategic planning basis. Of those that did, some favored proceeding with an early TRU repository if an opportunity is available and others, including all environmental groups that addressed the subject, opposed this recommendation. Some agreed with the IRG's statement that an early TRU repository would be consistent with the philosophy of conservatism and proceeding stepwise into the most difficult disposal problem, the disposal of high level wastes. Some of this group cautioned that pursuing an early TRU repository should not be permitted to delay the program directed towards opening the first high level waste repository. Many of the opponents argue that pursuing an early TRU repository is unnecessary and inconsistent with the IRG's more cautious approach to high level waste, particularly in light of the IRG's stateement that "issues related to long-term containment...are identical for TRU and HLW repositories." Others commented that an early TRU repository would bypass the EPA and NRC criteria and standard setting process.

Many of the commenters on the TRU strategy felt that the proposal for dedicated TRU repository is inextricably bound up with the DOE's proposed WIPP project and the proposed site at Carlsbad, New Mexico, this being the first and perhaps only opportunity that might be available for a dedicated TRU repository. Some commenters explicitly endorsed the WIPP project or stated that the early TRU repository should be put at that site. Several particularly stressed the utility of conducting R&D itself as a part of the project. Others argued that salt is an inappropriate emplacement medium for a repository, that the site is inadequate, or that the process by which the site was identified undermines confidence in both its adequacy and its proponents. Some commenters indicated that the danger associated with regional siting alluded to by the IRG is exactly what has happened with respect to the Carlsbad site. Others said the IRG was remiss or even deceitful in not addressing the issue of WIPP forthrightly and not being clear about the dependence of the early TRU strategy on that site. The proposal to place an ISF at WIPP was said to be inconsistent with the IRG's professed neutrality on the future of nuclear power. Some commenters argued that discussions and decisions on the WIPP project and the proposed site should await the publication of the EIS. Others criticized the IRG for not acknowledging the controversy over the project and the adequacy of the site.

Some industry commenters, supported the WIPP concept noting that:

- o The research and development nature of the WIPP program offers the additional opportunity to obtain important experimental information on burial of heat-producing radioactive waste through the emplacement of spent fuel rods. This extension to the WIPP R&D function could provide invaluable confirmatory data on the efficacy of waste disposal in deep salt deposits.

- o The WIPP Project for defense wastes should proceed rapidly and separately from the spent fuel storage AFR and waste repository facilities for commercial programs. An expansion of the scope of WIPP is desired to permit the disposition of limited quantities of spent fuel within a portion of the WIPP project and an independent review and approval of this limited spent fuel effort is desirable. However, WIPP should not be delayed in fulfilling its defense-related purposes.

The State of New Mexico commented that the IRG Report fails to specify the nature of the relationship between generic long-term national policy recommendations and the implementation of specific near-term geologic disposal programs. This issue is of great concern to New Mexico since the report notes that the near-term program, at least for TRU wastes, could conceivably be by means of the Waste Isolation Pilot Plant (WIPP) program proposed for this State. While there has been substantial discussion of the potential scope of the WIPP, they feel that final determination should be based upon the DOE environmental impact analysis that is being prepared. The State should be allowed to participate in any final determination of the scope of this proposed project.

A number of respondents expressed concern and dismay with the pace and schedule of the WIPP project with regard to the NEPA process and systems approach to repository siting. Comments from environmental groups included the following:

- The IRG omitted any discussion of the circumstances which led to the siting of the WIPP site. It also omitted mentioning the technical and political problems currently surrounding this site. WIPP would be located in bedded salt. The IRG's own subgroup on alternative technology strategies, however, suggests several serious drawbacks to salt as a disposal medium, including:

  (1) the frequent occurrence of economic mineral deposits, such as potash, with salt;

  (2) the high solubility of salt and the limited ability of scientists to predict future changes in groundwater flow regimes, climate or possible accidental flooding;

  (3) the low sorptive capacity of salt, i.e., its inability to "fix" radionuclides and retard their migration; and

  (4) the corrosion of waste canisters by salt.

These commenters further noted that:

- There is substantial political opposition in New Mexico to WIPP. Additionally, citizen groups in New Mexico are actively campaigning against the emplacement of waste at the WIPP site. Omission of these problems does not provide an opportunity for full understanding of the difficulties with an early TRU site.

- o The Waste Isolation Pilot Plant Project (WIPP) is bypassing the careful establishment of criteria, regulations and standards being undertaken by the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC) and is on a fast track. This project should be postponed until more methodical work is done and is publicly reviewed.

IRG Response:

The IRG has taken cognizance of the public comment on its proposal to adopt the notion of an early TRU repository (including the possibility of a colocated ISF) as an interim strategic planning basis pending NEPA review. The IRG still considers that proceeding with a dedicate TRU repository if an opportunity is available, is consistent with a conservative and stepwise approach. The issue of colocation of an ISF with a dedicated TRU facility has been discussed in the previous section on ISF's.

The IRG has also taken cognizance of the public comment on the interrelationship between its generic statements on TRU disposal and the WIPP facility under consideration by DOE for possible siting near Carlsbad, New Mexico. The IRG intends to address this question in its recommendations to the President and is still in the process of formulating its views on this matter.

The IRG wishes to reiterate that a TRU repository should be licensed and that legislation is required to accomplish this.

STORAGE, PROCESSING AND RELOCATION STRATEGIES FOR HLW AND TRU

The IRG finds that reprocessing is not required to assure safe disposal of commercial spent fuel in appropriately chosen geologic environments. Moreover, current United States repository designs are and will continue to be based on the ability to receive either solidified reprocessing waste or discarded spent fuel as a waste material. The question of whether commercial reprocessing will be initiated in the United States, while an important issue, is therefore not fundamentally related to the issue of safe waste disposal. Under the President's policy to defer commercial reprocessing indefinitely, it will be recosidered at an appropriate time in light of resource needs, technological opportunities and non-proliferation considerations. There are, therefore, no major technical issues at this time related to storing or processing of commercial spent fuel that require the President's review.[8]

Congress had directed DOE to study various means of disposing of the existing high-level waste at West Valley, New York. A report on this subject, "Western New York, Nuclear Service Center Study" is now in preparation and is expected to be published in November 1978. The IRG report cannot prejudge and therefore has not considered the site-specific issues of the West Valley study.

8/ A number of institutional issues do exist and those are discussed in Chapter IV of this report.

Public Comment:

Many commenters agreed with the statement, "The IRG finds that reprocessing is not required to assure safe disposal of commercial spent fuel in appropriately chosen geologic environments." Many others disagreed or criticized the IRG for not having given the technical basis for the statements. Some indicated that while the statement may become true in the future, today we now know how to dispose of reprocessing waste but not of spent fuel.

Several commenters criticized the IRG for not having adequately discussed the problems at the Nuclear Fuel Services facility in West Valley, New York. Others urged that quick remedial action be taken there.

IRG Response:

The IRG acknowledges that it did not provide the technical basis for its statements on the relationship of reprocessing and waste disposal and does so now. Spent fuel is chemically heterogeneous, containing more radioactive species than other high-level waste forms, and is not now well characterized as to chemical speciation. Contained gaseous species must be specially considered to avoid their becoming a potential hazard in the operational phase as well as after repository closure. For purposes of transportation and assuring retrievability for some specified period, special packaging will be required. Major gaps exist in current knowledge of the chemical interactions of spent fuel, its cladding and containers with salt or any other candidate repository host rock. Such questions are now receiving intensive study but at least several more years of work will be required before the chemical interactions are well understood and characterized.

Appendix A of the Draft Subgroup I Report stressed the need for the waste form to be compatible with the host rock. On reflection, it is now clear that this point was wrongly stated. The important thing is for the waste form and the host rock to be compatible. This can be done either by tailoring the waste form to the host rock or by choosing a host rock suitable for a particular waste form. If spent fuel is presumed to be the waste form, then a suitable host rock in a suitable hydrogeologic and geochemical environment must be found. Because of the special chemical features of spent fuel, there may be greater difficulty in finding an appropriate host rock and environment for spent fuel disposal. However, we know of no technical reason why this should not be possible.

The facilities at the West Valley site have been the subject of a separate study directed by the Fiscal Year 1978 DOE Authorization Act. The Act requested that DOE examine options available for the decommissioning and decontamination (D&D) as well as for continued use of the site. DOE was also asked to make recommendations with respect to responsibilities for D&D. The results of this nine-month study were to be submitted to a three-month public comment period. The report was released for public comment on November 22, 1978, and will be submitted to Congress in late February. The report does not recommend any specific disposition of the site. DOE has volunteered to submit such a recommendation in May 1979. The results of the nine-month study, the recommendations of the West Valley Tank Decommissioning and Decontamination Task Group (a special group organized by the New York State Attorney General's Office and the DOE), and the public comments received will be used as input for making the May recommendation.

Defense Waste

Currently, HLW from the defense programs is stored in underground tanks (Hanford, Washington, and Savannah River, South Carolina) and bins (Idaho Falls, Idaho) in the form of various liquids, salts, sludges, dry calcine powder (Idaho Falls only), and separated heat producers (Hanford only).

The Savannah River and Hanford high level wastes were initially stored in single shell tanks or tanks with a "saucer" as secondary containment (Savannah River only). Corrosion at stress points caused leaks that gained national attention. Subsequently, an aggressive interim storage strategy was adopted. Improved storage methods are being developed and double shelled tanks are being constructed to store liquids at Hanford and all forms of HLW waste at Savannah River. TRU waste is stored in containers on storage pads. All stored HLW and TRU waste is monitored carefully to ensure it remains immobile.

This near-term strategy for interim storage must be complemented with a long-term strategy for ultimate disposal. Several years of R&D have now defined alternative long-term strategies for each of the three locations.

Continued tank storage of defense waste is the safest near-term option; deferring recovery, processing and transportation to a later date would reduce risk of exposure from these activities because the radioactivity of the waste material decays over time. This approach, however, would require future generations to incur costs and risks avoided by this generation.

A second approach would be to remove the wastes from the tanks, separate and immobilize the radioactive materials, and package them appropriately for storage and eventual shipment to a permanent repository.

In comparing these approaches factors must be weighed that are not directly comparable: near-term hazards such as worker exposure and risks from processing and transportation versus the long-term hazards of tank storage. Similarly, high near-term costs must be weighed against lower costs over periods so long that discounting future may not be meaningful.

The IRG recommends the DOE accelerate its R&D activities oriented toward improving immobilization and waste forms and review its current immobilization programs in the light of the latest views of the scientific and technical community. Since final processing of defense waste has been deferred for three decades the IRG also recommends that remedial action, including immobilization of the waste, should begin as soon as practicable.

Public Comment:

Most commenters on the defense waste discussion agreed that the government should accelerate its remedial actions on existing storage sites and its efforts to immobilize defense wastes. Some commenters argued that such work should have highest priority. Others stressed the linkage between actions taken with respect to defense waste and public perceptions about commercial waste and nuclear power.

Several commenters argued that actions taken in the near term to immobilize the defense wastes should take account of the systems view of repositories and not foreclose future repository disposal options.

IRG Response:

The IRG agrees that any action taken to construct an immobilization facility for defense waste before a repository site is chosen should be designed to permit flexibility in the choice of waste form.

TRU waste is currently stored in a variety of containers on storage pads at Idaho Falls, Idaho and buried in shallow trenches at Savannah River and Hanford. The material stored at Idaho Falls is expected to be moved to a repository once one is available and in the meantime is carefully monitored to ensure that the radionuclides remain immobile.

The DOE is currently reviewing the question of whether this TRU waste should be incinerated, compacted and immobilized before being shipped to a repository. Pending the outcome of that review and the publication of an appropriate environmental impact statement, the IRG has not considered the matter.

For buried TRU waste, DOE should accelerate its environmental and technical analysis of disposal options at all DOE sites containing such material and reach a conclusion by mid-1982 on whether the buried material should remain in place or be exhumed and relocated for disposal.

CHAPTER III

TECHNICAL STRATEGIES FOR OTHER WASTE TYPES

Technologies exist for the management and disposal of LLW, uranium mill tailings and for D&D waste. However, existing practice must be improved considerably to further reduce the potential for public hazard associated with these materials. Consequently, increased emphasis needs to be given to the scope and vigor of R&D programs for developing improved technology for each of these materials. In addition, increased management attention is needed to ensure prompt implementation of that improved technology as it becomes available.

Brief summaries of the present technical situation for each of these three waste types are presented in this chapter.1/ 2/

LOW LEVEL WASTE

Most LLW, which is found in a wide variety of forms, remains radioactive for up to several hundred years. The current means of disposing of this waste is through shallow-land burial. At present, DOE has 14 active and 2 closed nuclear waste burial grounds, and commercial operators maintain 3 open and 3 closed sites. The commercial facilities serve the nation's nuclear power industry and other producers of nuclear waste such as hospitals and research organizations.

Projections indicate that commercial generation of LLW and thus the demand for burial ground capacity will increase dramatically in the decades ahead. Currently, over 2 million cubic feet of LLW are disposed of each year at commercial sites and over one million cubic feet at DOE operated sites. At the same time, however, there are increasing disposal charges. Moreover, waste acceptance criteria and operating methods are neither standardized nor uniformly enforced.

A coordinated national program for management of LLW wastes does not exist and this major institutional issue is discussed in Chapter IV. Technical issues discussed below involve the leakage of radionuclides from some existing burial sites; the need to monitor existing sites; and the development of improved and alternative disposal methods.

1/ More detailed discussions can be found in the previously published draft results of the IRG Subgroup on Federal Involvement, available from DOE on request.

2/ Discussion of institutional issues involving LLW will be found in Chapter IV. Work plans addressing the major technical and institutional issues for all all waste forms are detailed in Chapter V.

Radionuclides in low concentrations have migrated from the burial trenches at a few LLW sites. Studies to date conclude that such migration does not pose any present significant threat to public health and safety. Monitoring of future radionuclide migration from those sites over periods of decades should be considered as a potential regulatory requirement. This is highly desirable, first to protect the public, and second to collect data needed for validating existing radionuclides transport models so that they may be used realistically in prediction of future nuclide movement from old and new LLW sites.[3/]

In the future, siting of LLW disposal facilities should give much greater attention to the hydrologic characteristics of proposed locations than has been the case in the past. The IRG recommends that NRC and DOE take appropriate action to assure that this occurs.

Numerous technical approaches to LLW disposal have been proposed as alternatives to conventional shallow-land burial. Some of these require only a decision to use them and location of a suitable site to be implemented immediately. Others require additional technology development and perhaps demonstration before their feasibility and safety could be assured.

R&D for improved methods of shallow land burial of LLW and of alternative methods of disposal should be accelerated because shallow land burial, as currently practiced, may not be an adequate disposal method for all LLW in the future. Knowledge of the performance of shallow land burial and ocean disposal, as presently practiced, is primarily empirical. Best estimates indicate that these are appropriate methods for disposing of many types of LLW. However, the heterogeneity of the wastes, the extreme range of their physical and chemical properties, and their interaction with the ground or ocean sediments after disposal are, at present, sufficiently complex as to make it difficult to confidently predict their long term behavior and their potential hazard to man. Improved and alternative disposal methods will be required to meet the growing needs of LLW management.

DOE's existing land burial technology program is designed to upgrade all DOE's LLW operations by 1987. This program can be applied to commercial sites, consistent with EPA standards and NRC and state regulations. The overall goal to this program is to match available storage, processing, and disposal methods to the specific characteristics of the waste type. Major activities include classifying the different types of waste,[4/] developing methods for volume reduction, and developing and demonstrating improved disposal techniques.

3/ These models are similar to those used to predict nuclide migration from HLW and TRU repositories. Knowledge derived from such monitoring, therefore, will also be of value for HLW or TRU waste risk assessments.

4/ NUREG-0456, "A Classification System for Radioactive Waste Disposal--What Goes Where?" June 1978, is already widely distributed for public comment.

The IRG recommends that by 1981, DOE and NRC should review existing and alternative LLW disposal techniques and determine whether any should be adopted in the near future.

Public Comment:

Relatively few commenters addressed the technical issues related to low level waste. Of those that did, some endorsed the IRG recommendations, and others were critical.

The following points were made by those who criticized the IRG for giving insufficient weight to the problems of low-level waste disposal:

- assessment of the safety of current disposal technology is too optimistic and monitoring of low level waste burial sites for only decades might be insufficient. For example, some LLW facilities might pose a hazard for hundreds of years because some material sent to those sites actually should have been classified TRU or high level waste.

- comments such as "studies to date conclude that migration does not pose any present significant threat to public health and safety" downplays the risk that such threat could develop in the future.

- a need exists for the establishment of perpetual care standards for new methods of disposal, and for improvements in volume reduction technology.

The following points were made by those who criticized the IRG for expressing too much concern about the adequacy of current technology and the safety of current disposal sites:

- The IRG should not propose more requirements beyond those currently required by Federal and State regulatory agencies for managing low level waste because the half life of these wastes is very short and isolation for long periods of time is unnecessary. The statement that disposal practices should be "improved considerably" seems at variance with the fact that commercial sites are reviewed by State and Federal regulatory bodies, that these bodies have certified that commercial sites are in compliance with all applicable laws concerning radiological health practices and that the sites do not constitute a threat to public health and safety.

- The recommendation that "in the future siting of LLW disposal facilities should give much greater attention to the hydrologic characteristics of proposed locations than has been the case in the past," fails to take account of the extensive hydrologic investigation of present commercial low level sites prior to the licensing, the finding in NUREG-0456 that hydrology is not the most significant pathway in siting low level waste disposal facilities, and current programs by USGS, NRC, EPA and DOE to examine both geology and hydrology applicable to low level waste disposal sites.

- No technical basis is given for the IRG's statement that "shallow land burial, as currently practiced, may not be an adequate disposal method for all LLW in the future."

IRG Response:

The IRG did not undertake a detailed technical evaluation of current LLW disposal sites and practices or of various available and anticipated technical approaches to LLW disposal. In its discussion, the IRG may have failed to distinguish adequately between those sites chosen following thorough technical evaluation and others that were chosen with considerably less care. The IRG also agrees that many of the radioactive species contained in LLW decay rather rapidly. However, it is also true that in the early days of nuclear waste disposal, some waste was put into low-level burial sites that, under today's classification, would have been dealt with differently.

NRC should consider requiring the submission of a plan for monitoring as a prerequisite for future licensing of low level burial grounds. Monitoring may be desirable and/or necessary, for several decades or more. The development of improved technology and evaluation of the desirability of using other available disposal technologies should be pursued. The recommended DOE and NRC review by 1981 of existing and alternative LLW disposal techniques will examine these issues more thoroughly.

URANIUM MILL TAILINGS

Compared with other types of nuclear waste, uranium mill tailings are generated in large volume, about 10-15 million tons annually. Although tailings are a natural product of mining and milling, they are hazardous because they contain long-lived radioisotopes and because they have been left in waste piles where humans may come in contact with them. Radon and radium are two radioactive elements in these wastes that are of particular environmental concern. Radon is a noble gas that escapes easily into the atmosphere from unstabilized mill tailings, whereas radium, its parent, is a potential pollutant of surface groundwaters. Due to the long half-life of thorium-230, the parent of radium, the quantity of radon and radium in the tailings will diminish by only one-half in roughly 80,000 years.

The relative magnitude of actinide elements in mill tailings, HLW, and TRU wastes, per unit of energy generated, suggests that all these wastes streams may present problems of comparable magnitude for the very long term, that is, beyond a period of a thousand years. By virtue of their presence at the surface, the actinide elements in mill tailings may constitute a greater potential problem than those in deeply buried HLW and TRU wastes. Thus, disposal of these tailings must be managed as carefully as that for HLW and TRU wastes.

Past control of mill sites has been poor, with little or no attention to the problem of proper disposal of tailings upon completion of milling operations. Tailings have been removed from disposal sites for use in construction of homes and commercial buildings. Two general methods have been proposed for future containment of the tailings at old and new mill sites. The first involves covering the tailings with one of a variety of materials to reduce erosion and radon release. The second involves placement of the tailings below ground level in mines or in open pits.

Considerable R&D remains to be done to evaluate these measures. Moreover, the long half-life of thorium-230 dictates that R&D on tailings stabilization must consider the effects of geologic processes, operating over geologic time, upon the transport of radon and radium through the biosphere and hydrosphere surrounding the tailings. The ultimate objective should be to dispose of the tailings in such a manner that emissions of radon and radium are reduced to or as near background levels as can be reasonably achieved, and that no active institutional care be required to keep the tailings isolated from people following disposal. The risk-assessment methodology being used to evaluate the migration of radionuclides from proposed HLW and TRU waste repositories should also be used to estimate migration from uranium mill tailings.

<u>The policy approach for handling of the mill tailings, which is in progress and which is endorsed by the IRG, consists of</u>:

- Passage of legislation, now before Congress, that will authorize EPA to issue standards and criteria for disposal of mill tailings, establish NRC licensing authority over active sites and authorize DOE to take remdial action at inactive sites.

- Completion of a Generic Environmental Impact Statement (GEIS) on uranium milling by NRC.

- Development of standards, criteria, and regulations by NRC and EPA on acceptable levels of radon emissions, siting (to reduce the possibility of human exposure to tailings and to provide for long-term isolation), impacts on groundwater, and methods of ultimate disposal.

- o Determination and development of improved means of disposing of or stabilizing mill tailings over the long term. Only recently have innovative methods been initiated. Time is needed to evaluate these methods as well as to explore additional methods of disposal and stabilization.

- o Significant increase in DOE's R&D program on mill tailing disposal. This is already a major research area at EPA where the results are needed in the preparation of standards. In addition, EPA plans to conduct field studies at mill facilities to compare new methods with old.

- o Continuation of the present NRC practice of requiring licensees to reclaim the tailings in a way such that the radioactivity is reduced to near natural background levels and the possibility of human disruption and misuse is minimized.

<u>Public Comment</u>:

Compared to the attention directed toward high level waste, relatively few commenters addressed the uranium mill tailings. Of those that did, some endorsed the IRG's proposed policy approach, some argued that the IRG was representing the problems of uranium mill tailings as more serious than is warranted and others criticized the IRG for not giving sufficient attention to the problems that are more serious than suggested.

Several commenters stated their agreement with these sentences:

"By virtue of their presence at the surface, the actinide elements in mill tailings may constitute a greater potential risk than those deeply buried HLW and TRU wastes. Thus, disposal of these tailings must be managed as carefully as that for HLW and TRU wastes."

Others urged that these statements should not be interpreted to imply that uranium mill tailings required disposal in underground repositories or by other techniques applicable to high level wastes. Going to such lengths and expenses, they said, was unjustified.

The point was made that sufficient R&D should be carried out before criteria and standards are promulgated by regulatory bodies to be sure that excessive conservatism and expense are not built into the regulations, and that adequate flexibility remains until knowledge of the hazard is adequate. Solutions should be able to be site specific as necessary.

Those who criticized the IRG's treatment of uranium mill tailings for being insufficiently concerned about the associated hazards made the following points:

- o The IRG should not have left the evaluation of the problem and various approaches to solutions to later action by NRC and DOE, but should have undertaken the task itself.

- o If uranium mill tailings may present problems of a magnitude comparable to those associated with high level wastes, they should be buried deep underground in a similar fashion instead of being left on the surface.

- o The statement that technology currently exists for management and disposal of uranium mill tailings is incorrect. The technology for mine and mill tailings needs further development in order to meet NRC's goals of eliminating ongoing maintenance and monitoring after reclamation. Stabilization and disposal must be given high priority.

One commenter pointed out that existing tailing piles of TVA's Edgemont, South Dakota mill are not covered under the recent legislation on mill tailings.

NRC staff observed that the IRG report implies that no criteria, standards or regulations are in place and being used by NRC. In fact, they said, NRC has been aplying a set of criteria for over a year which will regulate radon, gamma radiation, and other radiological source terms at the reclaimed tailings area. All NRC licenses now have an approved reclamation plan.

<u>IRG Response</u>:

The IRG considers the safe disposal of mill tailings a matter of great urgency and importance but agrees that it did not conduct a detailed technical evaluation of the associated problems or of approaches to their solution. Since such an evaluation is underway at NRC in connection with the production of its Draft Generic Environmental Impact Statement on mill tailings, the IRG restricted itself to general policy guidelines in this area. The IRG's approach has three central components:

- o <u>Completion of regulatory action</u>. The IRG acknowledges NRC's current use of interim criteria in licensing, but stresses the need for EPA to complete its general environmental criteria and its various standard-setting tasks and for NRC to complete its GEIS and promulgate final regulations. A coordinating mechanism involving EPA, NRC and DOE has now been established under the cabinet-level Energy Coordinating Committee to expedite and coordinate the completion of these regulation actions.

- o <u>Taking remedial action on abandoned sites</u>. With the passage of Uranium Mill Tailings Radiation Control Act of 1978, EPA is directed to promulgate a standard for abandoned tailings sites within one year of enactment and, DOE now has authority, in cooperation with State governments, to begin remedial action on abandoned tailings piles. DOE is currently designating locations for attention and will soon enter discussions with appropriate states.

- <u>Develop and implement improved technology</u>. The IRG recommends that DOE increase its R&D effort in this area in coordination with the R&D conducted by EPA and NRC and that both DOE and NRC assure that technological improvements are introduced as soon as available.

The IRG is aware that the Edgemont mill, owned by TVA and a DOE-owned facility at Ray Point, Texas are not covered under the new legislation which excludes government-owned facilities. However, the responsible government agencies have authority to and should take what action is necessary at these sites to protect the public health.

The IRG's discussion of the objectives of the R&D program (to reduce radon and radium emissions to or as near to background levels as possible) was poorly formulated. The objective, better stated, must be at least to meet whatever standard is established by the regulators. The IRG feels it should not address the questions of what the standard should be or what technological approach to dealing with tailings is preferable. Such determinations should be made through the standard-setting and NEPA process.

WASTE GENERATED BY D&D

Nuclear power reactors as well as other nuclear facilities and some waste disposal sites will eventually reach the end of their useful lives. Ultimately, these facilities and sites will have to be decommissioned. There are currently no standards to guide such actions or agreement on what constitutes the best techniques and procedures to accomplish D&D. The nuclear waste resulting from any D&D operations will be voluminous, but not unique, and would be handled identically to equivalent waste types from other sources.

The D&D procedures and the disposal of the resulting wastes must protect public health and safety. As a general rule, unrestricted use of land should be the ultimate objective of D&D and institutional controls should not be relied upon after some period of time to provide long-term protection of people and the environment. However, because certain existing sites and/or facilities cannot be decontaminated at a reasonable cost, or perhaps at any cost, long-term institutional control may be required in these exceptional cases. These will require development of site-specific programs by the appropriate agencies (NRC and DOE).

The long-term institutional responsibilities associated with sites (or facilities) that are not released for unrestricted use must be established. Site controls, monitoring and surveillance requirements, as well as an effective record keeping system, similarly need to be developed. Funds for long-term care, guarantees and contingencies are also needed. Legislation is required to provide for long-term management and surveillance of decommissioned facilities not released for unrestricted use.

The precise actions to be taken in D&D cannot be specified in general since the requirements for particular sites and facilities will differ and must be carefully evaluated on a case by case basis. The types of techniques and procedures that might be employed singly or together include moth balling, entombment, dismantling, decontamination and removal. Very little experience with any of these techniques exists today and additional refinement of technology is clearly required. More importantly, nuclear facilities are rarely designed in a manner to facilitate eventual D&D. R&D in these areas is needed as well as the as the acquisition of experience on a priority basis.

Another high priority is the development of standards for both existing and new facilities for the unconditional release of land, material, and structures. EPA's General Environmental Protection Criteria and Waste Standards Rationale Document, to be issued in 1979, will provide guidance in this area. Rules and standards must also be and are being developed by NRC for the D&D of licensed facilities.

<u>DOE should prepare a nationwide plan for the D&D of surplus facilities owned by DOE and other government agencies and should consider ways to design and construct any new facilities in a manner that will facilitate D&D</u>.

Abandoned sites currently exist which, although previously decontaminated and decommissioned, do not meet current standards for release for unrestricted use. The remedial action required at such sites needs to be addressed. Since most of these sites resulted from activities in direct support of government programs, it would appear that the Federal Government should assume the responsibility for conducting the remedial action. Legislation would be required to delineate responsibility for funding and operation. The action would then proceed through the normal regulatory process.

For new facilities D&D specifications must be included in the initial design, and institutional arrangements must be made to ensure sufficient funding. Responsibility and methods for financing D&D of licensed facilities will be determined by the regulatory process. The funding for D&D of government-owned facilities and sites will be through Federal appropriations.

<u>Public Comment</u>:

Very few comments were received on the IRG's discussion of wastes generated by D&D. Several commenters explicitly endorsed the recommendations of the IRG in this area. Some commenters criticized the IRG for not adequately addressing the D&D waste problem and recognizing that the occupational hazard associated with its handling made it a unique class of waste requiring special attention. Some commenters urged that the cost of D&D be distributed over the lifetime of of a facility and others stressed the need to put aside funds at the beginning of a facility's lifetime. The need for case-by-case D&D plans was stressed by several commenters. Commenters also noted that high cost should not force society into relying on institutional controls for D&D.

NRC stated that the IRG report does not recognize the NRC program to develop standards and guidance for facilitating decommissioning of commercial facilities or NRC's major effort to obtain and approve decommissioning plans for all fuel cycle licensees. Plans have been obtained and approved from most types of fuel cycle licensees that will permit release of the facility for unrestricted use at the end of plant life.

IRG Response:

The IRG agrees that D&D waste pose special technical and occupational exposure problems. The IRG acknowledges NRC's activities in this area and urges NRC and EPA to complete their regulatory activities on schedule. In a similar fashion, planning for new Federal nuclear facilities should explicitly provide for D&D of such facilities and the IRG recommends that the estimated cost of such D&D be included in the total estimated project cost for such facilities at the time of authorization.

CHAPTER IV

INSTITUTIONAL ISSUES

The resolution of institutional issues required to permit the orderly development and effective implementation of a nuclear waste management program is equally important as the resolution of outstanding technical issues and problems. The solution of institutional problems involves difficult implementation issues and will require major Federal attention. The IRG has addressed a number of these issues which include:

- mechanisms for cooperation with State, local and Indian nation officials including:
  - coordination with Federal government
  - participation in the overall planning process
  - participation in siting of storage and disposal facilities
  - participation in the NEPA and regulatory review processes
- mechanisms for increased public participation
- institutional issues related to specific types of nuclear waste (spent fuel and LLW)
- institutional issues concerning U.S. involvement in international waste management
- institutional issues related to transportation

Public Comment:

Many commenters expressed substantial concern with the IRG's treatment of one or more institutional issues including the approach to implementation of the IRG recommendations. Many held the view that the IRG did not have sufficient opportunity to explore institutional issues in sufficient depth to provide the President with meaningful options for dealing with them. Many commenters felt that the importance of resolving institutional issues is understated and that solutions to institutional and political issues, will be more difficult to achieve than solutions to the remaining technical problems.

IRG Response:

The IRG would reiterate its previously articulated view that the resolution of institutional issues, required to permit the orderly development and effective implementation of a nuclear waste management program is equally important as the resolution of outstanding technical issues and problems and would add that the resolution of institutional issues may well be more difficult than finding solutions to remaining technical problems.

The IRG did attempt to deal with important institutional issues, including resource and logistical questions. In particular, many aspects of implementing specific IRG recommendations must be dealt with on a site-specific or facility-specific basis and therefore were not amenable to being addressed at the level of policy generality to which the IRG felt its task appropriately confined it. Moreover, the resource and logistical issues highlighted in the following paragraph were not examined sufficiently. However, the IRG did attempt to deal directly with the most important institutional issues and to set forth a conceptual framework for dialogue on such matters with various interested parties. Solutions to institutional problems cannot be developed quickly. Substantial time and effort will be required to explore alternative approaches in appropriate depth, which was beyond the capability of the IRG within the time frame of this review.

Significant institutional difficulties are involved in: marshalling the resources and programs capable of accurately detailing site suitability criteria and establishment of standards; thoroughly investigating possible sites; accurately assessing site characteristics in light of the technical criteria; carrying out credible analyses of the risks; obtaining agreement on site selection; getting the facility approved and licensed; providing for careful construction and operation of the repository (including safe transportation and handling of the wastes); mitigating accidents and responding to repository failure if that occurs; and providing adequate, long-term monitoring. The level of difficulty of all these problems could increase with the size of the nuclear nuclear waste inventory and its rate of growth. Institutions that can cope on a small scale may fail as the demands placed on them multiply. The IRG believes that a more detailed analysis of logistical and other institutional problems which would arise out of attempting to manage wastes on the scale require should be undertaken.

COOPERATION WITH STATE AND LOCAL GOVERNMENTS

The nature and scope of the nuclear waste management problems to be overcome in developing an acceptable, effective plan and program demand a planning and decision-making process that is open to wide participation by State and local governments and Indian nations. To ensure this partipation, the IRG recommends that the Federal agencies responsible for the design, development and implementation of the nuclear waste management program interface directly and extensively with all interested and affected parties. This can be accomplished specifically by inviting State, local and Indian nation officials to participate in:

- The overall planning process
- Consultation and concurrence in the characterization and selection of waste disposal sites
- The NEPA and regulatory processes.

Overall Planning

The benefits of nuclear energy are enjoyed, to a greater or lesser degree, by all of society. An increasing number of States are relying on nuclear power for electricity generation. Research, industrial, and medically-related activities, and those associated with the defense program, are designed to benefit the citizens in every State in the nation. The problem associated with the disposal of wastes generated in the process must therefore be addressed by society as a whole.

Each State has responsibilities for protecting its population, in terms of health and safety, against the potential hazards of such waste; and many States have already demonstrated the ability to manage nuclear material regulatory programs effectively. Furthermore, the States are calling for an increased role in the planning and development of a national nuclear waste management policy and program. Consequently, a genuine and effective partnership of "cooperative Federalism" should be initiated between the States and the Federal government.

To nurture a cooperative approach, the IRG considered a variety of institutional mechanisms including (1) specially created State Advisory Committees; (2) specially created regional advisory committees; (3) Federal-State task forces; and (4) separate liaisons with each different type of national organization of State State and/or local officials.

From this variety of institutional mechanisms, the IRG recommends that the President establish by Executive Order an Executive Planning Council. The Executive Planning Council would consist of selected governors1/, selected Indian nation representatives, officials of national organizations of State and local governments2/ and representatives of DOE and other Federal agencies.

The purpose of the Executive Planning Council is to:

- Identify joint Federal/State planning activities in nuclear waste management.
- Identify and agree on the appropriate existing or new mechanisms and timetables for carrying out such joint activities.

1/ These governors should represent a complete spectrum of States including those that have expressed opposition to siting facilities within their boundaries, and States with more neutral views, as well as States with major nuclear installations.

2/ Example organizations are: the National Conference of State Legislators, United States Conference of Mayors, National League of Cities, National Association of Counties, National Association of Regional Councils, and Council of Energy Resource Tribes.

- o Develop mutually acceptable criteria for evaluating proposed nuclear waste management activities (from R&D and geological characterization through the possible siting of disposal facilities.

- o Develop regional waste disposal facility siting plans and support State "consultation and concurrence" activities.

- o Support design, preparation, and evaluation of environmental impact statements covering waste management activities.

- o Develop a mechanism for planning which will effectively represent all interests and concerns not only at the State level (executive and legislative branch) but also at the local level.

- o Identify other Federal/State actions needed to maximize the likelihood of success of the overall program.

The Council should remain small in number to ensure effective and timely operations. Moreover, the Council should conduct its proceedings and carry out its planning activities in full public view. Such an approach would assure the public that its concerns were being given adequate attention.

This recommendation may require legislation to provide for funding over five years sufficient to provide staff support to the Planning Council in the accomplishment of the above tasks. Additionally, the proposed Federal/State and local/regional interface may require legislation at both the Federal and State levels, particularly in support of regional planning activities using existing mechanisms designed to incorporate local participation. Consequently, DOE should initiate a thorough review of existing legislation, once the IRG recommendations are adopted.

<u>Public Comment</u>:

Commenters in general supported increased state and local participation in the federal decision-making process for nuclear waste management. Constructive State participation in the Federal waste management program was said to require individual States to establish appropriate organizational mechanisms. These should be funded by the Federal government.

Most commenters criticized the lack of adequate definition of the scope, responsibilities, structure, role and authorities of the Executive Planning Council. Major comments and criticisms about the Executive Planning Council were:

- The IRG report fails to define precisely the role of the proposed Executive Planning Council in the waste disposal decision-making process, what authority the Council will have to enforce its decisions and the specific composition of the Council;

- With regard to authority, views ranged from support for an oversight body which would direct EPA, NRC, and DOE in the entire waste management process to the suggestion that the Council should be restricted to an advisory function and not have as a direct line function. As an advisory body, the Council should have a genuine opportunity to influence future waste management policy;

- The Council should participate in the development of objectives and policy related to nuclear waste management and should not be merely a convenient forum for DOE to sell its policies to the States. The fear was expressed that the Council could be dominated by or become a rubber stamp for DOE or function as a public relations tool for public co-operation;

- States cannot delegate to a Council their responsibilities to ensure that the health and safety of the public is protected;

- The generalized name title of Executive Planning Council fails to indicate an important role for elected officials on the Council. The intent of regionality and consultation and concurrence may be jeopardized by the failure to place the Governors in the position of lead responsibility. To emphasize the necessary lead role of the states, the IRG should both choose a name and define the Council's activities in a way more consistent with such a lead role for elected officials.

The most frequent comment on the Council's composition was that it is not broad enough to develop publicly acceptable criteria for evaluating activities and plans. For example, if the purpose is to develop policy concerning scientific and engineering matters, technical representation should be included to assure that policies are established which can be technically carried out. Missing were participants from industrial, scientific, State regulatory and rate setting authorities and citizens groups. Several commenters suggested that membership should also include regional organizations of governors and of States. This was said to be consistent with the IRG's recommendations for siting facilities on a regional basis.

Several States, public interest groups, scientific and technical organizations raised the following questions regarding the role of the Council vis-a-vis other IRG recommendations:

- o how would the Council implement the regionality recommendations;
- o what is the relationship between the Council's recommendations for repository site selection and the State's opportunity for consultation and concurrence;
- o what role would the Council have in the standard setting and NEPA processes;
- o what role would the Council have in impacting on-going DOE programs.

IRG Response:

The IRG feels that there is a special and very useful role for a body comprised of elected officials. At the same time there is also an important place for other advisory mechanisms comprised of technical experts, representatives of special interests and members of the public. Such mechanisms are discussed in the section on public participation.

The IRG agrees that the name Executive Planning Council is somewhat misleading in that it could be interpreted to imply a broader representation than is intended for this particular body. The name State Planning Council is proposed as more accurate and descriptive.

The IRG agrees that it provided incomplete explanations of why such a Council would be a useful mechanism and of what its roles, functions, structure, authority and staffing would be. A more complete description follows.

The IRG believes that the Council should be composed of elected officials appointed by the President and policy level representatives of the President. A Council of eighteen members is proposed. The chairman of the Council would be a Governor appointed and designated by the President. The Council would report its findings and recommendations to the President, the Secretary of Energy and the Congress.

The functions and responsibilities of the State Planning Council would not involve implementation responsibilities and would include the following:

- o Provide state perspectives for the development of the National Nuclear Waste Management Plan,the site characterization program and other waste activity planning and other planning documents to insure that they adequately address the needs of the states and localities;
- o Prepare an annual report on its activities to include its recommendations concerning the government's nuclear waste disposal programs;

- Advise on the regional distrification, characterization and placement of facilities for the management and disposal of nuclear wastes and review and make recommendations regarding the process for selecting, characterizing and determining the suitability of potential repository sites;

- Assist DOE and the states in recommending proposed sites for licensing by NRC to assure that the needs of the states and localities are met;

- Establish under its auspices such advisory committees as are deemed necessary to assist in its deliberations. Such committees should include representatives of all relevant interest groups.

- Defining additional State roles in the Federal Government's waste management program including State organizational and other institutional questions.

The SPC budget would be provided by the Department of Energy. Sufficient allowance for technical, legal or other professional services should be included. The Council would hire an executive director to serve at the pleasure of the Council. The director would have such technical, professional and administrative staff as is necessary to fulfill the functions of the Council. The staff should be composed of loaned or detailed personnel from state and federal levels. The number for states and federal staff should be equal.

Siting Activities

There has been growing concern over State acceptance of locating a Federally-proposed nuclear repository site within that State. Some members of the public have urged the IRG to rely exclusively on Federal supremacy for waste repository sites. Others have proposed that a State should have the authority to veto Federally-proposed nuclear waste repository sites within that State. Still others, including the National Governors' Association and the National Conference of State Legislatures, have proposed a Federal/State process of "cooperative Federalism" or "consultation and concurrence." Under this approach, the States would continue the involvement begun in the planning phase by reviewing early site characterizations and potential sites of disposal facilities. The State would be in agreement with each step in the process before the next activity was begun.

The IRG does not believe that a policy preference for either exclusive Federal-supremacy or State veto is appropriate at this time. The IRG does believe, however, and recommends that the "consultation and concurrence" approach should be adopted.

Consultation with the States should begin prior to the time when a State site is proposed for investigation. At a minimum, the consultation process should include: (1) soliciting technical, environmental, socioeconomic, institutional, and attitudinal information for the State executive and legislative branches of the public; (2) responding to the concerns expressed; and (3) assessing, or providing technical and financial assistance to conduct an independent assessment of potential environmental, socioeconomic and institutional impacts of a proposed nuclear waste disposal facility.3/

Public Comment:

The IRG recommendations for "cooperative federalism" and "consultation and concurrence" generated substantial comment. The IRG was strongly criticized for being insufficiently clear and complete in describing what it meant by these terms. The respective roles of the States and the Federal government and the limitations on the authority and responsibilities of each were not defined. Such fundamental questions as the extent to which the states and Federal government have and must themselves exercise the responsibility to protect public health and safety and who represents the State and by what mechanism is State authority exercised were not explored. Most particularly, whether the consultation and concurrence concept implies that States can refuse to permit federal activities and therefore maintain an effective veto was not clearly stated.

Many commenters felt that, to the extent they understood the intention, the IRG's proposal for a Federal-State relationship characterized by consultation and concurrence was desirable, appropriate and likely to be a constructive approach to siting. Some of these urged that the concept be embodied in legislation. Others argued that the States should not be permitted to prevent the the Federal government from conducting site investigations or construction of a repository. Still others, particularly those from State governments and environmental groups, argued that the States must retain the ability to veto the siting of a repository. In many instances the discussion supporting State veto was consistent with the IRG's concept of consultation and concurrence. In instances where commenters clearly did disagree with the IRG's proposal, the major argument was that consultation and concurrence was an attempt to co-opt the States by obtaining early agreement to federal activities which States would later find difficult to terminate or which the Federal government could later expand and consolidate by exercising preemption.

IRG Response:

The IRG recognizes that there are several proponents of legislation for State veto of DOE waste management decisions within those or perhaps any State. This view is a product of a number of factors, including the belief that wastes

3/ The results of such an assessment might be used to develop a plan, in consultation with the State, for mitigating any adverse impacts identified with such a facility.

should not be disposed of in particular States and dissatisfaction with the U.S. Government's historical approach in dealing with State participation in the site identification and characterization process. The IRG does not believe that prior approaches to Federal/State relations have been practical and constructive or that provision of State veto by itself will necessarily result in constructive participation by the States in the development and implementation of the waste management program.

The IRG believes that the technical and socio-political success of any Federal waste management program is largely dependent on the States; and in particular the extent to which the States are involved early-on in program planning R&D, site identification, site characterization, development of regional programs to assess geologic formations using the systems approach, and finally site selection. This should begin well in advance of the licensing and regulatory processes with participation early-on in DOE program planning.

The IRG agrees that it failed to articulate adequately what is meant by the terms "State veto" and "consultation and concurrence." By State veto was meant the possibility that a State could at one specific moment -- by one of several possible mechanisms -- approve or disapprove of Federal site investigation activities or a proposal to site a repository or other facility. The veto concept as used did not include an on-going dialogue and cooperative relationship between the Federal and State authorities.

Consultation and concurrence, by contrast, implies an on-going dialogue participation and the development of a cooperative relationship between states and all relevant Federal agencies during program planning and the site identification and characterization programs on a regional basis using the systems approach, through the identification of specific sites, the joint decision on a facility, any subsequent licensing process and through the entire period of operation and decommissioning. Under this approach the State effectively has a continuing ability to participate in activities at all points thoughout the course of the activity and, if it deems appropriate to prevent the continuance of Federal activities. The IRG believes that such an approach will lead to better protection of the States' interests than would a system of State veto by which is usually meant that a State approves or disapproves of Federal activities at one specific moment, as well as ensure effective State participation in the Federal Government's waste management program. Such an approach will also lead to freer access to areas for the conduct of geologic investigations.

NEPA and Regulatory Review

Successful planning and development of disposal facilities require State involvement in both the NEPA and the regulatory processes. Specifically, the IRG believes:

- o States should participate in the development and review of NRC and EPA regulations and standards that affect siting, public health and safety, environmental impacts, and financial responsibilities.

- o States should participate to a greater extent in NRC licensing procedures. Such participation should begin as soon as NRC receives notification of a pending application and continue until completion of the safety and environmental review. It should focus on identifying technical, environmental, economic, societal, and institutional issues of concern to the state. It should also permit the States to comment on all major, DOE prepared documents relating to nuclear waste management, and to work with the NRC staff in developing the outline and scope of required environmental documentation. (State representatives could even perform portions of the environmental analysis and accompany NRC staff on site visits.) NRC could assist the States by providing relevant information through public meetings, seminars, and exchange of staff members.

- o States should receive technical and financial help from the Federal government to help ensure the regulatory process is carried out fully when State licensing is involved.

Public Comment:

Virtually total agreement was expressed with the IRG's belief that the States should play a greater role in NEPA and regulatory review of nuclear waste disposal decisions. Some commenters indicated that the current level of State participation in NRC activities is greater than the IRG seemed to recognize.

PUBLIC PARTICIPATION

In addition to their interaction with State and local government entities, the Federal agencies responsible for developing a nuclear waste management plan and program need to interact with the public. The IRG's own experience with public participation and the recommendations of many citizens appearing before the IRG indicate the urgent need for sustained, effective efforts to inform the public and to provide opportunities for discussion between the public and the government.

Public participation in Federal decisions is required by the notice and comment provisions of administrative law, by NEPA via the EIS process, and through the process of wide ranging Congressional hearings on waste management. The public is therefore assured participation in such formal aspects of the waste management program as EPA's adoption of criteria and standards, NRC's promulgating regulations and licensing, and DOE's preparation of generic- and site-specific environmental impact statements.

Since extensive public controversy exists about the safety of waste management techniques and the adequacy of government programs, public participation in less formal ways on less formal occasions is also essential to the program success. In particular, opportunities are required for State and local authorities and the local public to participate in planning field work in their areas and in assessing and interpreting the data. Public input to the overall design and execution plan for both R&D and field investigations is also required. If technical or financial assistance is needed for any of these parties to permit such participation, it should be provided (as it now is, for example, to the New Mexico State government in conncection with proposed facility in that state). In addition, mechanisms should be available to assist in the obtaining of information and documents. The details of implementing a broad and meaningful public participation scheme needs to be worked out by the agencies involved as expeditiously as possible and should also be considered by the State Planning Council.

To generate a spirit of openness on the part of the government and of full participation on the part of the public, IRG recommends that, at a minimum, the President encourage, direct, and/or coordinate a program to:

- Routinely update the status of scientific and technical knowledge on nuclear waste management, and provide this information to the public at large in understandable terms.
- Increase interaction and discussions between Federal program managers and nationally or locally based institutions and organizations desiring such interaction and discussion.
- Support private sector efforts to generate a greater degree of social and technical understanding and agreement on nuclear waste management issues.

Public Comment:

The concept of and need for a social consensus as discussed in Chapter II of the draft Report received considerable comment. Some commenters asked what was meant by consensus and who would and should be included within it. Others argued that consensus on such a difficult and controversial subject is neither possible nor reasonable to expect. Others stated that while consensus might be possible, the delay required to achieve it is too great a cost. Still others urged that an Act or Resolution of Congress is the appropriate societal mechanism for expressing social consensus and that, therefore, the IRG should consider recommending that Congress act to articulate a consensus view or establish a criteria for a consensus and to resolve other outstanding institutional issues.

Virtually all commenters that addressed the subject of public participation agreed that additional and more effective mechanisms for increasing public participation are necessary. However, many criticized the IRG's particular suggestions. Opposition to intervenor funding was a frequent theme. Some argued that intervenors abuse the privilege of participation, impede the rights of others and prevent orderly processes of debate and consensus formation. Others argued that the IRG's performance in encouraging public participation was so poor that little confidence could exist in the ability of future Federal programs to do better. The importance of public education or of the government's need to inform interested parties of its activities was emphasized. Some said the IRG should have provided for a mechanism to coordinate Federal agencies' activities in this regard. Others cautioned against the dangers of government propaganda and opposed Federal support of industry or pro-nuclear groups' public relations campaigns.

A specific proposal was made for the creation of a Scientific Advisory Committee to advise DOE on technical aspects of its program and a more broadly based Public Advisory Committee to ensure effective two-way communication between the Federal government and concerned segments of the public, thereby improving the federal program and developing a broader understanding of that program outside of the Federal government.

Other comments bearing on the issues of public participation are summarized in the Section of Chapter IV on Overall Planning and the section of Chapter V on Organizational Issues.

IRG Response:

The IRG agrees that the term social consensus is difficult to define and perhaps inappropriate as a description of the degree of agreement needed to move forward. Nonetheless, the IRG does believe that without a wide spectrum of support at least for the procedures adopted, little forward progress can be made while debates on virtually all aspects of the programs must be expected to continue, only if the procedures for dispute resolution are perceived to be legitimate will the outcome be seen as legitimate.

The IRG wishes to restate its commitment to expand the mechanisms available for meaningful public participation and emphasize that more thought is required to develop new mechanisms and expand existing ones. The IRG acknowledges the danger that government and private sector information efforts can become propaganda campaigns. Nonetheless, the IRG feels waste management decisions must be made following open debate where in which information is available and varying points of view are represented. The IRG still believes that technical or financial assistance should be provided as needed to permit informed public input to programs and decisions and that non-governmental efforts to increase social and technical understanding and agreement on nuclear waste management issues deserve government support. Appropriate criteria should be developed by relevant government agencies.

The IRG believes that all Federal Departments and agencies, including the independent regulatory agencies, that have responsibility in radioactive waste management andd disposal can and should benefit from the advice of technical experts and the public. Advice should be sought from expert technical agencies of the government such as the U.S. Geological Survey, professional scientific and engineering societies, review groups such as the National Academy of Sciences, individual scientists and engineers, and or organizations, the utilities and others in the commercial sector, and individuals representing public interest groups and the public itself. The IRG recommends that agencies with continuing responsibilities in waste management and disposal ensure that mechanisms for such advice are strengthened in their respective Departments and agencies.

INSTITUTIONAL ISSUES RELATED TO WASTE TYPES

A number of institutional issues pertaining to nuclear waste management relate to specific types of nuclear waste (spent fuel and LLW) and to specific cross-cutting activities (international cooperation and transportation). These are discussed in the next sections of this chapter.

Spent Fuel

In October 1977, the United States announced a new policy for managing spent fuel. One major difference between this policy and the one it replaced is the emphasis on considering alternatives to reprocessing spent fuel in the near term. Proposed alternatives include interim storage; ultimate disposal; or both in sequence. The approach finally selected would be made available to all domestic/commercial power reactor operators as well as to a limited number of foreign governments when it would serve U.S. non-proliferation objectives.

The IRG recommends that the implementation of the President's Spent Fuel Policy should be pursued vigorously and appropriate legislation be submitted to Congress.

Analysis to date indicates that 1983 is an appropriate planning date for additional Away-From-Reactor (AFR) storage. However, earlier availability of AFR storage for some foreign spent fuel would be of significant assistance in achieving important non-proliferation objectives.

As input to decisions on implementation of the spent fuel policy, three GEISs have been or will be issued in draft on: (1) storage of spent fuel from U.S. power reactors (Issued); (2) storage of spent fuel from foreign power reactors (to be issued November 1978); and (3) storage/disposal charges (to be issued December 1978). Illustrative fees and methodologies for the storage/disposal options have already been published for public comment.4/ Despite this progress, several major institutional issues remain and are discussed in turn below:

4/ "Preliminary Estimates of the Charge for Spent-Fuel Storage and Disposal Services," DOE/ET-0055, July 1978.

- o The availability of adequate AFR storage capacity
- o Liability for nuclear accidents
- o Financial responsibility for the cost of storing and disposing of spent fuel
- o The acceptance and storage of spent fuel from other countries
- o U.S. involvement in international, cooperative efforts for spent fuel storage
- o Safeguards and physical security

Public Comment:

Numerous commenters, primarily from industry, argued that spent fuel should not be disposed of permanently but kept in interim storage and thus be available for possible reprocessing to recover potential energy value. Many of the industry commenters agreed with the IRG recommendation that the government act quickly to implement the President's announced spent fuel policy and make AFR storage available as soon as possible.

Many other commenters, especially from environmental groups, argued that spent fuel should be stored at reactors and not moved to central storage facilities unless absolutely necessary. They criticized the IRG for not providing data and analysis to support the contention that AFR storage is necessary. Some charged that the spent fuel policy was a government subsidy to the nuclear industry.

The suggestion was made that the federal government should accept U.S. commercially-generated spent fuel only after a mandatory period of storage under the management of the electric utilities. This period should be selected by the Department of Energy and stipulated to the nuclear industry to be consonant with several policy objectives:

(a) to provide a predetermined and known period of time for spent fuel storage prior to canning or special processing;

(b) to establish the basis for an orderly and manageable flow of material from nuclear power plants to final disposal;

(c) to minimize the need for AFR storage of that material during this flow; and

(d) to be consistent with the time that spent fuel can be stored before it requires special canning for safety for environmental reasons.

The commenters suggested, as a first guess, that such a period of mandatory utility storage might be about 15 years.

IRG Response:

The question of spent fuel reprocessing is not a matter to be decided within the context of waste disposal since, as stated elsewhere, there is no reason to expect that suitable sites cannot be found for safe disposal of spent fuel. Reprocessing could become part of the commercial fuel cycle in the future if it becomes economically attractive and if an institutional framework for handling the weapons proliferation implications of the use of plutonium can be worked out. Repositories will be designed to handle either spent fuel or waste from reprocessing. For the period that spent fuel is stored above ground, the option will exist to recover the contained plutonium and uranium by reprocessing.

The IRG agrees that to the maximum extent possible spent fuel should be stored at reactors. Appropriate acceptance criteria will be required, but whether a specific cooling time, as suggested, is the preferred approach is not now clear. Further analysis is required. Nonetheless, based on analysis available to the IRG and contained in the three published DOE draft environmental impact statements on domestic and foreign spent fuel policy and related charges for storage and disposal, the IRG believes that conservative and prudent planning leads to the conclusion that some AFR storage capacity should be available roughly in the 1983 time frame for domestic use and could be needed earlier in connection with acceptance of foreign spent fuel. In addition, the IRG feels that at least one AFR can play an important role in buying time and permitting greater programmatic flexibility in the development and opening of HLW disposal repositories. Storage in AFRs must not, however, be permitted to be a substitute for continuing progress toward opening the first repository.

Availability of AFR Storage Capacity

The needed AFR storage could be made available from existing facilities (at Barnwell, South Carolina; Morris, Illinois; and West Valley, New York), or from new facilities designed and constructed by DOE and private industry and leased to the government. The Tennessee Valley Authority (TVA) is considering the development of nuclear waste storage facilities to serve its own needs, and has indicated its plans could be modified to accommodate the nuclear storage needs of others. These options are under active consideration.

Public Comment:

On the question of siting, some commenters suggested AFRs should be placed at sites of future repositories. Others, recognizing repository sites may not have been chosen at the time an AFR is built, cautioned that the siting of an AFR should not prejudice the siting of repositories.

IRG Response:

The IRG agrees that if the site of a future repository is known at the time of siting an AFR, there would be advantages of colocation. However, the first AFR will almost certainly be sited and likely be in operation before HLW repository locations are determined with certainty. The first AFR siting decision, therefore, should be separate from and not prejudicial to repository siting.

Liability for Nuclear Accidents

A number of individuals and organizations, both within and without the government, have raised the question of liability in the event of a nuclear accident involving the transportation, storage and disposal of spent fuel. Further legislation on this matter is believed to be unnecessary.

NRC has the discretion, under Section 170(a) of the Atomic Energy Act, to require a licensee maintain financial protection (some base amount of private insurance, etc.), and execute an indemnification agreement for public liability. Under Section 170(d), DOE could enter into an indemnification agreement with any of its operating contractors if it determined that such activities involved the the risk of public liability for a "substantial nuclear incident." Coverage under the provisions of the Price-Anderson Act is currently available. Both of these sections provide for considerable discretion and would permit the indemnification of spent fuel storage or disposal facilities; however, in neither case does the statute mandate or require that coverage be extended to such facilities.

The extent to which activities at an AFR or a waste repository will be covered by a Price-Anderson indemnity agreement has not yet been established by the agencies involved and specific action will be required by them.

Transportation of spent fuel to or from an indemnified facility is covered under the indemnification agreement for that facility. Thus, transportation of spent fuel from a commercial reactor to a repository would be covered under the indemnification agreement for the reactor facility. Transportation from an AFR to a waste repository would also be covered upon the indemnification of either of these facilities.

Public Comment:

Very limited comment was received on this topic. Most responses addressed the policy question of whether the Price-Anderson Act should be used to cover the liability of AFRs and transportation to AFRs. Arguments were made on both sides. Some commenters questioned whether the Price-Anderson Act could be used for this purpose and urged that this matter be reexamined.

IRG Responses:

The IRG continues to believe that its description of the situation in the draft Report is accurate. However the IRG did not then and has not now addressed the policy question of whether or not Price-Anderson should be be employed.

Financial Responsibility for Storage and Disposal

This subject is discussed in the section on Costs and Financing of Chapter V of this report. However, the IRG wishes to emphasize that the costs of AFR storage for the domestic utility industry should be paid for by that industry and borne by the ratepayer.

Acceptance of Foreign Spent Fuel

Internationally, the thrust of the Nation's new international policy on nuclear fuels, of which the spent fuel policy is a key element, is to:

- o Demonstrate, through deferring reprocessing, the need to proceed cautiously in the commercialization of reprocessing and of breeders and opportunity
- o Initiate and participate in the International Nuclear Fuel Cycle Evaluation (INFCE) to find more proliferation-resistant ways to meet future nuclear energy needs
- o Develop assurances on the supply side of the fuel cycle, (e.g., uranium availability and enrichment services) to reduce near-term incentives for early development and commercialization of reprocessing and breeders
- o Collaborate with other countries to examine spent fuel management alternatives to near-term reprocessing, including establishment of multinational interim storage facilities and repositories
- o Pending such developments, provide storage for limited amounts of foreign spent fuel in the United States, when it supports U.S. objectives of international nonproliferation

The decision to accept spent fuel from a specific country are expected to be made on a case-by-case basis, measured against one or both of the following criteria:

- o The country is located in a region in which protracted availability of spent fuel would be ill-advised in terms of nonproliferation objectives.

- The acceptance of the spent fuel would lead to significant non-proliferation gains (e.g., by encouraging alternatives to developing a national reprocessing capacity to meet spent fuel disposal needs, by stimulating implementation of desirable regional or international fuel cycle approaches consistent with overall U.S. policy, or by inducing adherence to the Treaty on the Nonproliferation of Nuclear Weapons).

In the past, shipment of research reactor spent fuel to the United States has been handled in normal merchant marine commerce, on a vessel space-availability basis. However, when power reactor spent fuel is transported to the United States, the increased volumes may make dedicated vessels desirable. Also, assessment of sea operational requirements may determine that special vessel design features may be necessary for the sea transport environment. Such developments will be facilitated by United States participation in international cooperativee efforts concerned with the sea transport of spent fuel.

Many of the uncertainties remain about the disposition of foreign spent fuel generated from fuel initially supplied by the United States. Some of these uncertainties will probably have to be resolved through "subsequent arrangements" under the Atomic Energy Act and the Nuclear Non-Proliferation Act of 1978. With this approach, the Sectetary of State would play a leading role in policy negotiations, and the Secretary of Energy would assist in these negotiations and coordinate the implementation -- i.e., an organizational framework similar to that described in the Nuclear Nonproliferation Act. The existing interagency activity, under the general direction of the Departments of State and Energy, is presently addressing such matters as:

- Identification of means to provide some limited, near-term (i.e., before 1983) AFR capacity for the storage of foreign spent fuel;

- The amount of foreign spent fuel to be accepted under the President's offer, and the related consideration of the stringency with which the decision criteria for such acceptance should be applied;

- Transportation and cask availability, including related licensing, acceptability, and liability questions;

- Special siting and ownership questions concerning multinational AFRs and

- Appropriate roles for the International Atomic Energy Agency and other international organizations.

The timely resolution of these issues and concrete progress in our domestic nuclear waste management program would increase the credibility of the program and of the United States nonproliferation policy, as well as enhance the possibility that other countries may join with the United States in developing adequate spent fuel storage capacity. Indeed, an early and technically successful U.S. waste disposal program that is clearly acceptable to the American public could accelerate the decision process in other countries and possibly lead to the establishment of some internationally available disposal facilities.

Public Comment:

Very limited response was received on this topic. Comments included:

- The report did not specify the countries involved or provide a detailed rationale for pursuing this concept.
- Special efforts should be utilized to reduce the risk of sabotage or diversion of foreign spent fuel shipments.
- Accepting foreign spent fuel may be a subsidy to countries having internal problems on nuclear waste management policies.
- This program would compound the problems that already exist with domestic spent fuel management and waste disposal.
- The U.S. should work with all countries to share common experiences in solving spent fuel management issues.

IRG Response:

The IRG believes that use of the proposed criteria for determining when foreign spent fuel is accepted by the United States will protect against the program becoming a subsidy or a substitute for environmentally safe and proliferation-resistant storage that countries could themselves provide. The details of implementation, as the IRG noted, must emerge from existing interagency activity.

Low Level Waste

Initially, the Federal government assumed responsibility for disposal of all radioactive wastes. Later, with increased industrial participation in the nuclear industry, commercial nuclear waste disposal services were provided for LLW by private industry and licensed and regulated by the AEC (now NRC) and Agreement States. The Federal government has continued to manage and dispose of wastes generated from defense programs at DOD-operated sites.

Operational problems have contributed to the closing of two commercial sites (Maxey Flats, Kentucky and West Valley, New York) by action of the individual State or site operator. A third site (Sheffield, Illinois) is closed pending an NRC decision on license renewal and expansion of the site. In addition, a fourth site (Barnwell, South Carolina) has administratively limited, the monthly quantities of waste it is prepared to receive. As a result, little flexibility exists if operational problems occur at the remaining two sites (Beatty, Nevada and Hanford, Washington). Sufficient capacity exists at the DOE-operated sites to handle government wastes and some of this capacity could be made available for commercial wastes if the need should arise. Should DOE propose to receive commercial wastes at the DOE sites, however, this could create a capacity problem at DOE sites and, in addition, be viewed as federal subsidy of an industry or federal competition with the private sector.

A classification system is needed and is being developed by NRC for LLW, based on the type and duration of containment required for their safe disposal. Using projections of the kinds and quantities of LLW to be generated, and analyses of shallow land burial and improved disposal methods, a determination is needed as to how many of what types of sites are required. However, there presently exists neither a coordinated national program for management of these wastes nor an institutional mechanism to deal effectively with these issues.

Under the present implementing framework, private industry must take the initiative to identify and submit for licensing approval any new land burial sites for disposal of commercial low-level wastes. Such action includes purchase of land and deeding the land to the Federal or State government. The site operator is responsible for the costs of assuring safety of sites during operations. As land owner, the Federal or State government is responsible for the long-term control and safety of the site. Funds have been established by individual States to defray costs for such long-term care.

Recent events have shown, however, that the existing type of implementing framework does not properly work today in all cases. For example, most long term care funds have been deemed insufficient to cover projected costs for two reasons. As a result of inflation, costs have escalated faster than capital accrues through interest, and funds have been needed for corrective action prior to final D&D. Some States have taken a strong position against siting of disposal sites in their States. National planning that assures an adequate number of sites, regionally located and available when needed, is not occurring.

The IRG recommends that DOE assume responsibility for developing and coordinating the needed national plan for LLW with active participation and advice from other concerned Federal agencies and input from the States, general public, and industry in its formation. This would constitute a specific sub-element of the overall waste management planning approach discussed in Chapter V.

The IRG further recommends that States be provided the option to retain management control of existing commercial LLW sites or to transfer such control to the Federal Government.

Future sites could be developed either by the individual States or by the Federal Government but such actions should be taken within the agreed-upon framework of an overall LLW siting plan, developed through a joint Federal/ State partnership, and using the mechanisms proposed earlier in this chapter.

Low level waste sites, subject to regulation, would be regulated either directly by the NRC or by the State through the Agreement State process. In the former case, NRC should provide for an expanded role for the State in participating in the NRC licensing process; in the latter case, NRC should provide more definitive guidelines to the state for minimum regulatory requirements than has been the case up to now. By this process, any remaining significant differences in the two regulatory approaches, as measured by the quality of operation of the burial ground and financial protection afforded, would tend to diminish in importance.

New DOE LLW non-defense sites would also be licensed. All LLW disposal activities, whether managed by DOE or the States, would be subject to compliance with overall EPA standards, thus providing improved uniformity in all such operations towards protection or public health and safety.

Public Comment:

All comments received from State Governors and legislators and from various State agencies on the IRG recommendations concerning low level waste supported the IRG recommendation that DOE develop and coordinate a national plan for LLW, with active participation and advice from other concerned Federal agencies and input from the States, the general public and industry. However, some of these commenters added the proviso that the States should retain the right, within such planning, to veto the placement of LLW site within the State. All were favorably disposed to the IRG recommendation that the States be provided the option to retain management control of existing commercial LLW sites or to transfer such control to the Federal Government. However, a number of commenters pointed out that the concept of "management control" under the option for trans- to the Federal Government needs further definition, particularly with respect to such matters as land ownership, facility ownership, financial liability, operation, monitoring, decommissioning, inspection, long-term care and licensing. The States should be assured active involvement.

A commercial low level waste burial ground operator urged that any transfer of title from the State to the Federal government should be subject to existing commercial leasehold and contractual terms and that the Federal Government not compete with the private sector in offering disposal services on a contractual basis. Proposals were made for a National Low Level Waste Trust Fund to be financed from burial feeds that would provide for the long term care and maintenance of all commercial low level waste burial sites and for Congress to prohibit states from imposing levies on low level waste burial operations.

The following are some specific recommendations and suggestions of LLW disposal advanced by other reviewers:

- NRC should provide mandatory regulatory requirements for agreement States. States must retain the authority to establish more stringent standards and requirements, if they chose.

- NRC has initiated an analysis of alternative organizational roles and institutional arrangements for the LLW site control functions. The results of this analysis, to be available in early 1980, will provide guidance for NRC recommendations on modifications to existing organizational roles and, more importantly, will identify the action and procedures to implement these.

- One of the viable alternatives for LLW disposal which has not received sufficient investigation is the use of regional collection and processing centers with disposal in Federal lands which are already dedicated to perpetual care (i.e., Nevada test site). These regional centers would economically reduce volume and stabilize low-level radioactive and other hazardous waste prior to shipment by specially designed and dedicated trains to the designated Federal lands. The obvious advantage of this alternative would be the sparing of public lands which otherwise would be dedicated to waste disposal.

- The Report pays undue attention to wastes relating to nuclear power generation. Industry, hospitals, educational institutions, etc., need to dispose of low level waste. The cost of disposal is increasing. Wastes must be transported greater distances because fewer sites are available to receive them. This problem should be resolved in the next year or two.

IRG Response:

The IRG noted the response to its recommendations that DOE assume responsibility for developing and coordinating the needed national plan for LLW with the active participation and advice from other concerned Federal agencies and input from the States, general public and industry and that States be provided the option to retain management control of existing commercial LLW sites or to transfer such control to the Federal government. The IRG reconfirms its support for these recommendations. The IRG intends that the consultation and concurrence process discussed previously would apply to LLW siting no less than to high level waste siting and therefore that an ongoing dialogue and cooperative relationship would exist between the Federal and State governments from the time of initial federal interest in site investigations in a State to the point of joint decision whether or not to site a LLW burial facility. Under this approach the State effectively has the continuing ability to impact upon the Federal activities at any point throughout the course of the activity.

By transfer of management control to the Federal government, the IRG meant that all responsibilities for care and inspection, all liabilities, leasing authorities and land ownership would revert to the Federal government. Where States currently license under agreement with NRC, the licensing authority would revert back to NRC. In exercising its rights and fulfilling its responsibilities in this area, the Federal government would, of course, work in close consultation with the States.

When the NRC provides the more definitive guidelines to agreement States for minimum regulatory requirements that the IRG proposes, those States would still be free to adopt more stringent requirements if they wish.

Matters related to conditions of transfer from State to Federal control as they affect the private sector will be considered in the drafting of the proposed legislation and in individual discussions with States. The IRG feels that one component of the Trust Fund discussed in Chapter V, with separate accounting from the high level waste component, should be used for providing for care of Federally owned low level waste sites. The proposal for regional LLW collection and processing centers and disposal on Federal land already dedicated to perpetual care is among those to be examined by DOE in its national LLW plan. The IRG is certainly cognizant of and concerned about the current problems experienced by industry, hospital, educational and research institutions and others in disposing of low level waste. The national planning of low level waste disposal that DOE will undertake should resolve the problems of these waste generators no less than the problems of the utility industry.

U.S. INVOLVEMENT IN INTERNATIONAL WASTE MANAGEMENT EFFORTS

In the past, the United States government, through the DOE and NRC, has participated in numerous bilateral and multilateral nuclear waste management efforts. Many other countries, notably Sweden, The Federal Republic of Germany (FRG), Canada, the United Kingdom, Japan, Belgium and Italy, have active nuclear waste management programs.5/ The United States cooperates with these nations on such activities through the Organization for Economic Cooperation and Development's Nuclear Energy Agency, the International Atomic Energy Agency and the International Nuclear Fuel Cycle Evaluation (INFCE).

The waste disposal programs of such countries, have different orientations or emphases than those of the United States. Because our program is now broadening into examination of a wider range of geologic environments and media, new technologies for packaging and processing waste, and alternatives to mined repositories, the experience of other countries in these areas could

5/ Appendix G summarizes current waste management activities in various countries.

be very valuable. In addition, other countries are developing and exercising specific risk assessment models and other components of evaluation and regulatory systems. Further, knowledge available in the United States on the safe disposal of spent fuels should be made available to other countries through cooperative agreements which would assist in achievement of our nonproliferation objectives. Finally, in instances in which identical or very similar laboratory or in situ tests are needed, it would save both time and resources to conduct such work on a cooperative basis, and the United States should seek and encourage such cooperation. On-going activities are substantial but should be reexamined for possible increase in scope.

Under the new spent fuel policy, U.S. participation in cooperative international waste management efforts may have shifted somewhat but has not diminished overall. To guide future requests from other countries for U.S. participation in waste management efforts, the IRG recommends the following three guidelines:

1. Any integral part of a spent fuel reprocessing system or any technology that directly supports the separation of uranium and plutonium should be treated as a reprocessing technology. The decision to participate in any effort that involves such a technology should be subject to existing United States policy on cooperation in this area. However, exceptions might be made for studies of alternatives to reprocessing, if the policy-level judgment is that the overall benefits outweigh the drawbacks.

2. International cooperative efforts focusing on waste management not directly coupled to reprocessing but involving separated waste may be considered for United States participation, where we are already committed to such cooperation. In addition, new cooperative ventures involving coherent, responsible nuclear power programs that cover spent fuel disposal as well as waste reprocessing appear acceptable. For example, the United States might agree to exchange its technical expertise in waste solidification for other countries willingness to examine the spent fuel disposal option.

3. International cooperation on studies of waste management technologies that apply equally to spent fuel and waste reprocessing should be encouraged. Such studies would include spent fuel storage technology, geologic examinations, risk assessment, and transportation.

All participation should be considered on the basis of mutual benefit to be derived -- i.e., the United States and foreign technical information and data to be exchanged should be reasonably equal.

As with any facility at which nuclear material is stored and processed, a nuclear waste disposal repository requires adequate physical security measures to prevent sabotage or theft of material. These measures would be commensurate with the volume of nuclear material present, its form and packaging, and the intrinsic difficulties would-be saboteurs or thieves would have in handling the material.

A nuclear waste repository falls within the types of facilities that the United States has offered to submit to IAEA safeguards. Therefore, the facility should be designed and built to facilitate the application of such safeguards. However, because the nuclear material contained in a repository obviously cannot be actively inventoried once the waste canisters are emplaced and the passageways sealed, some modifications in standard IAEA safeguard procedures, as provided for the in the basic international agreements, will be necessary. The United States should work with the IAEA and other countries to develop such modified safeguards procedures and any related instrumentation.

IRG Comment:

Upon further consideration, the IRG would now revise its three guidelines on this subject to read as follows:

1. Any integral part of a spent fuel reprocessing system or any technology that directly supports the separation of uranium and plutonium should be treated as a reprocessing technology and handled consistent with U.S. policy. Exceptions might be made for studies of alternatives to reprocessing, if the policy-level judgment is that the overall benefits outweigh the drawbacks.

2. Existing international cooperative efforts focusing on waste management not directly coupled to reprocessing but involving separated waste should be continued. New cooperation efforts in this area should be reviewed on a case-by-case basis.

3. International cooperation on studies of waste management technologies that apply to spent fuel storage or apply equally to to disposal of spent fuel and separated waste, should be encouraged. Such studies would include spent fuel storage technology, geologic examinations, risk assessment, and transportation.

TRANSPORTATION OF NUCLEAR WASTES

Transportation is an important element of the overall waste management system. Attention to safety here is equally as important in highway, barge, and rail traffic as in every other aspect of the system. This concern for safety is needed to improve the public acceptance of the transportation of nuclear waste. It is centered around the possibility of inadvertent release of radioactive material. It is the view of informed experts that, for appropriately designed shipping containers, this will not occur during normal operation nor in most serious accidents. While complete assurance is impossible, it has been demonstrated that it is highly unlikely that a significant release can occur under any credible accident environment. Greater assurance that the relationship between accident severity and packaging integrity is well understood is perhaps the crucial element in achieving greater public and carrier acceptance.

One effort to demonstrate cask integrity in a severe accident has itself become an issue. In 1977, the Energy Research and Development Administration, in conjunction with Sandia Laboratories, conducted demonstrations of the performance capability of last-generation shipping casks in crashes. These full-scale crash tests provided some evidence of the ability of the casks to withstand serious impacts. Sandia found that the full-scale tests verified the results of their scale-model testing and computer analysis experience. However, the railroad industry has declined to accept the test results as conclusive evidence of cask integrity in accident conditions, believing that scientific test criteria were not met.

Another important issue involves the fact that a large increase in the inventory of casks and vehicles will be needed to ship DOE, TRU waste and spent fuel, later in this decade. Procurement lead times are long, experienced fabrication capability is limited and industry incentives are uncertain. However, it is expected that the United States industry will meet this need once DOE has established a firm implementation program for spent fuel storage and nuclear waste management.

During its deliberations on the transport phases of waste management, the transportation subgroup of the IRG met with representatives of the railroad, highway, and merchant shipping industries to discuss carrier concerns and solicit their recommendations.

As noted earlier, the railroad representatives expressed concern about safety risks and their opinion that more requirements are needed to avert serious accidents and attendant disruptions.

The highway representative expressed concern about increasing restrictions on transportation at State and local levels, even though the industry's actual transportation safety record has been exemplary. Indeed, at other public meetings and discussions, the concern of State and local officials regarding the safety of transportation through or near populated areas was evident.

The IRG views the recent initiation of a public rulemaking proceeding by DOT as a very important step towards resolution of this issue. DOT should proceed expeditiously to examine the desirability of Federally prescribed routing requirements for barge, rail, and highway shipment of radioactive wastes, as well as the question of to what degree local restrictions are appropriate.

Further specific IRG findings and recommendations on transportation matters are as follows:

- A coordinated program for testing and evaluating the performance of current and future generation packaging systems during accident conditions is required. DOE in conjunction with NRC, DOT, and EPA, and with input from the nuclear and transportation industry, should identify the program needs for testing and evaluating the performance of current and future generation packaging systems during accident conditions for all forms of transportation including barge, rail, and highway.

- DOT with assistance from other agencies and industry, should develop a data bank on shipment statistics and accident experience to be operational by 1982.

- Assurance should be provided for early state participation in the barge, rail, and highway routing planning process and include consideration of transportation issues in the scope of activity in the Executive Planning Council.

- Ongoing NRC and DOE studies to help define the need for physical protection measures for nuclear waste transportation should be completed by March 1980 and any rulemaking needed should be completed by 1981.

- Federal assistance in the development of capability for handling emergencies should be expanded, involving all levels of government.

Public Comment:

The IRG's recommendations for addressing transportation issues within the context of nuclear waste management were the subject of substantial comment from States, utilities, and the transportation industry. Many commenters expressed concern over the lack of depth in the transportation discussion contained in the draft report. Others criticized the apparent lack of analysis leading to the recommendations and the resultant lack of clarity in the intent of the recommendations.

Aside from a general concern about the adequacy of the IRG examination of transportation questions, most comments were focused on specific issues raised in the report.

- General support was indicated for expediting the DOT examination of the desirability of Federally prescribed highway routing requirements for radioactive materials transportation. Although some believed a similar examination of barge and rail routing should be considered, it was generally agreed that highway routing is the acute issue requiring early resolution.

- o Preferences for the outcome of the DOT rulemaking ranged from complete Federal determination and preemption of all State and local requirements to freedom for localities to exercise stricter routing and other controls. States generally requested assurances that they would be able to have impact on decisions before they were finalized.

- o A concern for comprehensive management of nuclear waste transportation was surfaced. Many suggestions addressed the need for a structure which would be responsible for regulation and enforcement, emergency response, routing, hardware development and production. Because of fragmentation of responsibilities at the Federal level, some commenters recommended that a lead Federal agency serve as the final authority for all matters related to safe transportation of nuclear materials.

- o Other public recommendations not only addressed the management issues but also the need for coordinated Federal and State relations. Some commenters called for establishment of a review team consisting of DOE, DOT, NRC, and representatives of State and local governments. This team would function in an advisory capacity on all nuclear transportation matters.

- o Several comments from States indicated their concern for transportation as a major issue in resolving the entire nuclear waste problem. Many sought assurance that transportation would be a central feature of the proposed "consultation and concurrence" process.

A number of commenters, including the railroad industry, criticized the IRG's failure to analyze the question of special train service. The railroad industry believes that controlling the transportation environment by requiring dedicated trains, reduced speeds, and various operational controls will increase the level of safety for carrying spent fuel casks. Opponents to this concept generally stated that the higher cost would not be justified by the incremental increase in safety.

Some commenters raised questions regarding liability in transportation accidents involving nuclear materials and Price-Anderson Act coverage of such accidents. A concern raised because of the question regarding licensing of waste repositories and storage sites was the need for transportation to and from such facilities to be covered by Price-Anderson. Some believed that the Federal Government should assume full liability for damages arising from accidents.

Several commenters questioned the meaning of the IRG's recommendation for increased Federal assistance in developing emergency response capability. They believed that such capability must be ensured by the Federal Government, either through response teams or training assistance to States and localities.

IRG Response:

The current DOT examination of routing covers only highway transportation of nuclear materials, including wastes. DOT initiated this rule-making in response to the proliferation of local legislation and regulation which threatened to disrupt the transportation network and decrease the overall level of safety. Highway traffic control, maintenance, and regulation of intrastate motor carriers have long been the subjects of State and local jurisdiction. By contrast, rail transport is governed by a single Federal agency and carriers perform traffic control and maintenance under Federal standards. Rail routing is limited by prevailing track configurations and conditions rather than local regulation. Barge transport allows even fewer routing options. Based on these factors, the IRG emphasizes the need for early completion of the current rule-making on highway routing and believes the DOT should monitor transportation of nuclear materials by other modes so that any problems can be foreseen and examined before they are allowed to adversely affect the transportation of nuclear wastes. The IRG urges the DOT in its public rulemaking proceeding to consider the entire range of preferences and encourages States and localities to deliver their comments and concerns directly to the DOT throughout the rulemaking.

In its review of transportation issues, the IRG did not find information to support a Federal reorganization. In its deliberations, the IRG reviewed current statutory authority and regulatory overlap in transportation of nuclear materials. While considerable overlap in authority exists between NRC and DOT, neither this overlap nor the ongoing relationship between the two in the management of day-to-day activities appears to result in serious problems. The two agencies have worked well in the past. They now propose to revise their coordinating arrangements and to handle those difficulties that do exist by a revision of their existing Memorandum of Understanding. The division of responsibility embodied in the proposed MOU appears reasonable.

Although the IRG does not believe a reorganization of Federal agencies is necessary, it sees advantages in having an advisory group which includes representatives of State governments. The State Planning Council, discussed elsewhere in the report, will be encouraged to establish a transportation subgroup to meet this public recommendation.

The IRG reiterates its strong concern about transportation as an essential link in nuclear waste management. It believes that transportation will be a primary topic in discussions with States and therefore certainly included in the consultation and concurrence process.

The IRG supports a strong Federal-State relationship for transportation regulation and enforcement and in the draft report recommended that DOT and NRC review their existing program with States. The IRG believes that State participation in this transportation surveillance program should be expanded and additional funding provided. Also, the IRG believes NRC and DOT should identity additional responsibilities which could strengthen the role of States.

The IRG agrees that special train services as proposed are likely to provide greater safety for any commodity but sees the issue as being whether greater safety precautions are needed and at what cost. Existing NRC cask specifications and the design approval process provide assurance of cask integrity and survivability in transportation accident conditions. Performance testing of casks can also contribute to that assurance or identify needs for packaging modifications. The IRG believes that confidence in the packaging does not preclude an examination of the benefits and associated costs of special trains and believes that a neutral study is prerequisite to resolution of this issue. Therefore, the IRG believes that DOE should fund such a study, and emphasizes the need for objectivity in assessing the benefits and costs. DOE should ensure participation of both shippers (utilities) and the railroad industry in determining the scope and approach of the study.

With regard to the liability question, the Price-Anderson Act along with its legislative history and regulatory implementation supports the conclusion that coverage is provided whenever shipments move to or from an indemnified facility. At present, the Price-Anderson Act provides a limit on liability and government indemnification of a portion of third party liability claims that result from any accident on the site of a licensed facility as well as during transportation to or from such a facility. The IRG believes the current system and limits provide reasonable coverage for credible transportation accidents and finds no support for change or new legislation in this area.

To date, there has been no occasion to license an AFR or waste repository nor, therefore, to indemnify any DOE contractors operating such a facility. Both options exist under the Atomic Energy Act of 1954, as amended, and the effect of either option would be an extension of Price-Anderson coverage to the site and to transportation to or from it.

The IRG examination of emergency response accepted the premise that emergency planning and response are primarily State and local agency functions. However, many localities do not have the capability and resources for adequate preparation and planning. Therefore, the IRG has recommended greater Federal assistance, with expectations that it would occur primarily through the existing framework of the Interagency Radiological Assistance Program. The IRG recommends that DOT take the lead, now in the NRC, for assisting States in planning and training. DOT is expanding its capability to provide emergency information on all hazardous materials. In addition, the establishment of the Federal Emergency Management Agency under a recent Reorganization Plan is expected to provide greater strength to the Federal programs. The Federal structure does emphasize guidance to State and local agencies rather than actual on-site assistance. The IRG believes that the review of NRC and DOT State programs should include emergency response considerations.

CHAPTER V

MANAGEMENT CONSIDERATIONS

ORGANIZATIONAL ISSUES

Three approaches to managing a nuclear waste disposal program are:

- o Using ad hoc or formal interagency committees to coordinate independent programs;
- o Assigning primary responsibility for planning and managing nonregulatory programs and for interfacing with regulatory programs to a single agency; or
- o Assigning primary responsibility for planning and managing nonregulatory aspects of the program to a newly created independent Government authority.

The first approach would be cumbersome as an ongoing management method and would lack a programmatic focal point. The third approach would provide a focal agency for managing necessary programs but would delay actions that should be taken immediately while the structure was defined and the authority was organized. The second approach would also provide an organizational focus and would avoid disruptive structural changes. It would also maintain the appropriate perspective of waste management in relation to other energy production and energy-related environmental issues. The IRG recommends that the second approach be adopted and that DOE be given the primary responsibility for developing and integrating the overall planning for the nonregulatory program and for interfacing with the regulatory programs.

To maintain the independence and integrity of the regulatory process, the relationship between DOE and the regulatory agencies should include the following principles.

- o The work plans developed by both regulatory and nonregulatory agencies should be analyzed to determine inconsistencies;
- o Discussions with appropriate agencies should be initiated when problems exist in the timing and scope of products; and
- o Work plans should be adjusted when it is convenient and acceptable to all interested parties.

When accommodation is not possible all interested agencies would take the issue to the President jointly.

One major task of the DOE would be to update the comprehensive nuclear waste management plan within the context of the national energy policy. These updates would be delivered simultaneously with the National Energy Plan beginning in 1981, but would receive independent public review and comment. One component of this activity would involve updating the documents prepared by the IRG setting forth the status of knowledge relevant to various technological options for disposal of HLW and TRU wastes.

Furthermore, DOE must provide the capability to implement the recommendations set forth in this report. In particular, it should:

- Incorporate the outputs of the Executive Planning Council into the overall national planning;
- Interact with the public on nuclear waste management matters;
- Develop detailed plans for implementation of the NEPA process, accomplishment of program R&D, and for the D&D of surplus Federal facilities;
- Ensure objective, independent assessment of technical R&D results
- Implement the approved nuclear waste management plan.

Finally, to prepare for the operational tasks of nuclear waste storage and disposal, DOE should develop a management structure with four important characteristics:

- Well-defined program authority
- A decision-making process that leads to stable operating policies
- Efficient (i.e., businesslike) operations
- A separate cost accounting system.

Public Comment:

The IRG was criticized for not having given sufficient attention to organizational mechanisms for implementing its recommendations and for not discussing organizational issues and alternatives in sufficient depth.

The IRG's recommendation that DOE be given primary responsibility for developing and integrating the overall planning for the nonregulatory program and for interfacing with the regulatory program received extensive comment. Most commenters agreed with the IRG that a single lead agency is needed to provide focus and management authority to the waste management program. A few commenters disagreed and proposed that overall coordination or oversight be vested in a perpetuated IRG or in the Executive Office of the President.

Opinion was divided as to whether DOE or a new Federal entity should have the lead responsibility. Those arguing that a new federal agency and not DOE should have the lead expressed the belief that DOE would continue the policies and approaches of its predecessor agencies which were judged to be inadequate and that DOE is more committed to disposing of waste quickly than carefully. The major arguments for vesting the lead in DOE were that the job would be done well that way and a disruptive, time-consuming transfer of authority would be avoided.

Other comments received on organizational matters included:

- the IRG did not adequately address the problem of the relationship among the various involved Federal agencies or the implications of any of the three alternative approaches identified.
- the IRG recommendations do not correct the existing fragmentation of decision-making or lead to clearly defined accountability for program management
- the IRG should have addressed the internal DOE structure dealing with nuclear waste. The suggestion was made that the responsibility for waste management be raised to an Assistant Secretary level.

IRG Response:

The IRG agrees that a summary of implementing actions needed to be taken by various involved agencies would have been helpful. This is being prepared for submission to the President and will be published subsequently.

The IRG understands that a portion of the public would prefer assigning overall responsibility for waste management to an agency other than the Department of Energy. The IRG continues to believe, however, that any transfer to a new agency would involve considerable delays and disruption of on-going programs and would not, in itself, necessarily solve the problems perceived to exist with DOE and its predecessor agency programs. The IRG believes that the DOE can and must conduct the waste management program in a responsible, careful and open manner and that, over time, DOE can gain public confidence in its ability to do so.

If all of the IRG recommendations are accepted, a substantial number of oversight mechanisms and external views would impact the development of the DOE program. These include:

- Congressional review and legislative direction;
- Joint participation of state and local governments;
- Increased broad scientific and public participation;
- Executive Office budgetary and major program review; and
- Licensing reviews.

These activities will be helpful to DOE and the public in assuring that the program direction is sound and implementation is responsive.

WASTE MANAGEMENT COSTS AND FINANCING

Costs

The IRG has reviewed several aspects of the costs of nuclear waste management and how those costs should be financed. The estimated costs associated with the implementation of the waste management program are summarized in Appendix D. The result developed there, and drawn directly from the DOE Task Force report of February 1978, is that total government costs through the end of the century for R&D, interim storage and ultimate disposal of both defense and commercial wastes would range from about $15 billion to $25 billion. These estimates are still preliminary and do not include offsetting revenues from the commercial sector which would significantly reduce the net Federal outlay.

DOE estimates are admittedly very rough and require additional refinement. The IRG recommends that the DOE update and extend these estimates to include post-2000 costs. This is needed to give a more complete picture of the long-term cost implications. The IRG found the available data insufficient regarding the costs associated with remedial action for uranium mill tailings, and with D&D of both commercial and government facilities. DOE should proceed expeditiously to improve and include cost estimates for these activities.

The costs of a comprehensive waste management program of the type represented by the work plans contained in this report fall into two basic categories: defense-related activities and commercial-related activities. Categories of costs include research and development, capital construction and facility operating costs, transportation costs, as well as indirect government support costs. The policy regarding recovery of these costs is that defense-related costs should be borne by the taxpayer since they result from activities required to provide for the common defense of the nation. Government cost which derive from activities required to support commercial activities (power production, research, medicine, etc.) should be paid by the generators of the waste and borne by the beneficiaries of such services. Hence, the largest portion of these latter costs will be borne by the electric utilities and ultimately the consumers of electric power.

A carefully applied separate cost accounting system and allocation methodology is important to ensure the proper distribution of costs to defense and commercial accounts. In addition, a careful review of historic expenditure is required to assure that any appropriate items in support of commercial activities are clearly identified and properly incorporated in future charges.

Financing

As indicated above, the projected costs of handling and disposal services by the government for commercial radioactive wastes will be covered from the commercial sector requiring such services. The major portion of these costs will be associated with the storage and/or disposal of spent fuel from the nuclear power industry.

With respect to spent fuel storage and disposal fees (which may be collected by more than one method), the following objectives appear appropriate for consideration:

- The charge should be based upon full government cost recovery and should reflect only the actual services provided (storage and disposal only) so utilities would not be penalized for providing their own interim storage.

- Government outlays should be minimized to the maximum extent possible.

- The charge should be nondiscriminatory, readily recovered by the utilities, and paid by those benefiting from the power produced by the spent fuel.

- The payment mechanism should be simple and readily understandable by the public and utilities.

It is currently estimated that the government charge for spent fuel storage and disposal to be levied on the nuclear utility industry would add on the order of 1 mill/Kwh to electricity costs. Methods of calculating these charges have been made available for public comment by DOE 1/ and a specific charge or fee should be established by 1980.

Options for collection of the fee are either the use of contract vehicle, outlining payment and delivery terms; or the use of a fee based on generation of electricity while the fuel is still in the reactor.

1/ "Preliminary Estimates of the Charge for Spent-Fuel Storage and Disposal Services," July 1978, DOE/ET-0055.

The IRG recommends that DOE continue to conduct analyses to determine the method of payment which will best serve the combined interest of the public and the ratepayer and that a decision be reached on this by the time of submission of proposed spent fuel legislation to the Congress, presently estimated to occur in early 1979.

Options for treatment of funds received are:

- o Application to the DOE budget as an offsetting revenue for all DOE activities (status quo);
- o Establishment of a separate trust fund, or its equivalent under DOE management for waste disposal expenses only; or
- o Payment directly to the United States Treasury.

The IRG recommends that DOE analyze alternative methods of cost recovery to generate full funding of a trust fund or its equivalent so as to assure that the revenues received are adequate and are properly applied directly to the waste management program. Recommendations resulting from the analysis should be incorporated promptly into the budget cycle.

Public Comment:

Comments reflected agreement with the concept that all costs be paid by the generators of waste and borne by the beneficiaries. Some said the trust fund concept is the preferred mechanism to implement this concept. Many commenters argued that mechanisms are needed to protect taxpayers from the potential cost of subsidizing rate payers in the event of cost overruns and incorrect estimates. The one-time charge was said to be particularly inflexible and inappropriate in this regard.

Some commenters objected to the stated objective of minimizing government outlays and argued that the government must be prepared to pay whatever costs are required. Others argued that the task of assigning costs to the rate payers is the responsibility of State public utility commissions and not the prerogative of the Federal government.

The suggestion was made that the cost of remedial actions on D&D and uranium mill tailings should be included in the cost-recovery calculations for commercial waste disposal.

Industry commenters argued that the one-time charge should be based on full cost recovery over a reasonable period of time and collectable at the time of delivery of spent fuel to the government. Payment in advance of deliveries was considered unreasonable. Provision should be made for recovery of the value of fissionable material if in the future the decision is made to reprocess.

IRG Response:

The IRG now recommends the establishment of a trust fund and will recommend that the President submit appropriate legislation to the Congress at the earliest opportunity. The matter of the timing of payment of the fees for spent fuel storage and disposal is still under review. The objectives should be to minimize transfers between taxpayers and rate payers and to maximize the availability of front end financing to the government, not to minimize total government outlays. The President's spent fuel policy includes a provision to permit compensation to utilities, as appropriate, if a decision is made in the future to reprocess.

Virtually all abandoned mill tailings piles that will be attended to by the Federal and State governments under the provisions of the Uranium Mill Tailings Radiation Control Act of 1978 resulted from mining and milling operations that supported the Atomic Energy Commissions' activities related to national security and research and development programs. The IRG does not believe that the cost of clean-up of those tailings piles should be charged to commercial nuclear power. Decontamination and decommissioning expenses of government facilities should be charged to the commercial waste management cost accounts only in those instances where the costs of construction and operation of these facilities are also charged against commercial waste management.

LEGISLATIVE REQUIREMENTS

A number of substantive initiatives are required to provide the Federal agencies involved with the authority required to implement the activities called for in this report. The additional authority falls into two broad categories: that needed to support licensing/regulatory changes and that required to permit implementation of programs. A summary discussion of the background, current status, and scope of new legislation, referred to throughout this report, is presented below.

Licensing/Regulatory Legislation

- Extension of NRC licensing authority to cover new DOE facilities for interim storage and possibly disposal of spent fuel from commercial reactors.

  Prior to enactment of the Energy Reorganization Act of 1974, the U.S. Government's nuclear programs, carried out under the authority of th Atomic Energy Act of 1954, were not subject to licensing. Section 202 of the Energy Reorganization Act extended NRC licensing authority to certain specified nuclear activities which are now being carried out by DOE. The language of Section 202, however, makes it unclear whether NRC licensing authority would extend to DOE facilities used to implement the President's policy to accept spent fuel from commercial reactors. Such facilities would include those used for receipt, storage, and possible disposal of such fuel. (The latter action could also be achieved by NRC rulemaking.) Legislation clarifying the NRC authority in this area would facilitate implementation of the President's policy.

- Extension of NRC authority to cover ultimate disposal of DOE generated TRU and nondefense low-level wastes, at the minimum, at new sites.

Program Related Legislation

- Establish a mechanism which will permit participation in the decision-making process by State, local, and Indian nation officials and the public at large.

  This report calls on the Federal agencies responsible for program development to interface directly and extensively with all interested and affected parties in developing and implementing an acceptable radioactive waste management program.

  Although a great deal of assisttance can be rendered under existing law, new legislation would be required to assure that sufficient authority is available to make expenditures for such items as state energy office staff support to the proposed Executive Planning Council. In addition, though not requiring formal legislation, Congressional support of the concept of "consultation and concurrence" in the form of a Concurrent Resolution would be valuable.

- Federal Ownership of existing and commercial low-level waste sites.

  Existing commercial low-level burial sites are currently owned and operated by private companies and regulated either by NRC, or under the Agreement States Program, by State governments. Legislation would be required to support Federal ownership of commercial low-level burial sites. If commercial burial sites are to be operated by DOE and licensed by NRC, legislation would also be required.

- Implementation of the U.S. Spent Fuel Offer.

  The U.S. government currently has no authority to accept spent fuel from either domestic or foreign parties for the purpose of providing either storage or disposal services. In order to to implement the President's announced policy, authority would be required to obtain the needed storage capacity, enter into long term contracts, to provide storage of spent fuel, establish an appropriate compensation mechanism, and obtain the needed funds.

- Surveillance of decommissioned facilities not released for unrestricted use of and remedial action at abandoned sites.

  Establishment of the long term institutional responsibilities associated with sites or facilities that are not released for unrestricted use is required. Similarly, authority and responsibility for remedial action required at previously abandoned sites which do not meet current standards for unrestricted use, need to be clearly established. Legislation is required to define agency responsibilities and to provide the necessary authority and funding.

IRG Response:

Comments relating to legislative proposals, whether proposed by the IRG or independently by commenters are discussed in the appropriate section of the report, rather than in this summary section. The IRG still considers this list to be the appropriate list of legislation to be recommended to the President, except that the proposal to provide a general fund (as discussed in the earlier IRG Response on Financing) would be added to the list.

DRAFT WORK PLANS

The following set of detailed work plans constitutes a plan of action intended to assure the safe and effective handling and disposal of radioactive wastes. The work plans cover the major types 2/of waste, decommissioning of surplused radioactive facilities, and transportation in support of all activities. The plans identify agency actions and significant milestones that were developed and discussed in the reports of the six working groups of the IRG. The plans were developed by type of waste and not by source or origin of material. They identify a substantial number of opportunities to involve the public in shaping, reviewing, and commenting on the suggested approaches. Public interaction milestones include publication of environmental impact statements and NRC licensing activities.

2/ High level waste (including spent fuel), transuranic wastes, low level waste, uranium mill tailings, and similar wastes from decommissioning operations.

The plans focus on the schedules and events leading to the development and/or construction of initial facilities for managing each type of waste. Additional facilities as required would follow in a logical sequence. A summary of the key events identified in the individual plans is presented in Exhibit V-1.

The plans do not identify needed R&D. However, R&D programs will be required to support the major elements of activity for each waste type. The development of detailed R&D programs as required, should be a priority activity under each plan.

The work plans are intended to provide perspective with regard to the timing of major events. They are based on the assumption that programs and events will proceed in conformance with current expectations. Dates are program targets and schedules are idealized. There are varying degrees of uncertainty associated with the actual likelihood of specific events. In order to provide a a complete picture, the outcome of certain future decisions and the duration of certain future activities must be assumed. Therefore, the following work plan schedules show the earliest possible date to complete an event. Estimates of uncertainty are shown in some cases to indicate the possible range of slippage associated with a single event and/or the total project.

Selection of specific alternatives and their associated implementation reflects today's best estimate and should not be interpreted as pre-determining, prejudging, or influencing the actual results in any way. The plans, as displayed include assumptions that decision point requirements (e.g., EISs, licensing events) are successfully met. If this is not the case, or if new knowledge or other circumstances so dictate, plans must be revised accordingly.

Public Comment:

Some commenters argued that the draft workplans were too idealized and lacking in sufficient detail to permit adequate evaluation and effective tracking of progress. The suggestion was made that tentative results expected from major decision points shown on the work plans should be identified. More discussion is needed concerning the interrelationship among the major decisions and events in each program element and discussion is lacking entirely of the interrelationship among the various major program elements.

Doubts were raised about the adequacy of the NRC and EPA regulatory schedule in relationship to one another.

Doubts were also raised about the ability of agencies to hold to the 1979 schedule as prescribed. Some commenters questioned the need to take so many procedural, standards-setting, classification and regulatory actions so quickly. They argued that the only reason for haste, where these actions relate to HLW, was a belief that the early repository option would be followed and that proceeding at the rapid rate would not permit citizen groups to respond adequately to draft documents and standards. This schedule, therefore, would be incompatible with the commitment to increase public understanding of and participation in Federal programs.

Other commenters urged that the repository program and regulatory agency schedules be accelerated even more than the IRG had proposed.

IRG Response:

The IRG would reemphasize that the schedules are idealized in the sense that they do not take account of delays and slippages that could occur for many reasons. The regulatory schedules of NRC and EPA will be further examined by the two agencies as they seek to address the general question of their relationship in a Memorandum of Understanding. The IRG agrees that if the high-level waste interim strategic planning basis does not include the possibility of an early repository some procedural, standard-setting, classification and regulatory items in the work plans could be delayed somewhat from an operational standpoint; however, the majority are needed in any event to guide the R&D programs and site characterization activities. The agencies involved will be sensitive to the conflict between the need to move forward and the need for effective public participation.

EPA STANDARDS AND CRITERIA

Objective

Exhibit V-2 summarizes the major criteria and standards required of EPA to fulfill their responsibility of providing Federal radiation protection guidance and establishing generally applicable environmental standards. The schedules represent an acclerated program effort to be compatible with the work at NRC, DOE, and other agencies. The criteria and standards set by EPA are general rather than site specific and serve as the basis for NRC regulations and DOE operations.

Strategy

In 1979, EPA will provide general or "umbrella" environmental criteria applicable to all radioactive waste. This will provide an interpretation of the basic criteria for waste management in terms of requirements to be satisfied. Also in 1979, EPA will complete the waste standard rationale document which will provide the radiation protection objectives and possible approaches upon which environmental standards will be based. These two efforts will provide the framework within which NRC will develop its regulations and DOE will base its operating criteria and evaluate options in its waste management program.

The next phase of the EPA program will develop specific numerical standards applicable to waste classes. The schedule for completion of the specific standards is as follows:

1979	High level waste
1979	Transuranic waste - stable form
1979	Interim guidance - active uranium mills
1979	Inactive uranium mill tailings
1980	Airborne pollutants associated with uranium mill tailings
1981	Residual activity - decommissioning
1982	Transuranic waste - other forms
1983	Low level waste - shallow land burial
1983	Low level waste - sea disposal container standard
1985	Active uranium mill standard

High Level Waste

Objective

The objective of this effort is to accomplish the development, design, licensing, construction, and operation of an initial geologic repository for the long term isolation of high level waste (HLW), including unreprocessed spent fuel consistent with applicable safety and environmental requirements. This includes development of associated processing and storage facilities as appropriate as well as general and specific regulatory standards and environmental criteria.

Strategy

EPA is developing General Environmental Criteria applicable to all radioactive wastes, which will provide basic criteria to be satisfied by waste systems. These will provide an interim basis upon which NRC can proceed with the development of regulations and DOE can continue on-going operations. Subsequently, EPA will promulgate a specific HLW Standard which will contain specific numerical standards for HLW, including spent fuel elements. NRC is developing and will issue regulations to be satisfied for licensing facilities for disposal of HLW. They are also preparing a Waste Classification System that will classify radioactive wastes according to the type and duration of confinement required for their safe disposal. All of the above standards and criteria development will be completed in 1979.

DOE will continue its on-going programs of interim storage of defense HLW, retankage operations, and waste stabilization programs. DOE will complete by 1980 environmental impact statements for each of its three sites with high level waste that address the issues, options, and risks associated with processing HLW for long-term management. Additional EIS's will be prepared to analyze the various alternatives for disposal of the waste at each of the sites. These documents will be a major element in the decision-making process for long-term management of defense HLW. A Generic EIS for similar treatment of commercial wastes will be completed in 1979.

DOE proposes to implement the U.S. spent fuel policy by providing away from reactor (AFR) storage facilities in the 1982-1984 timeframe pending the availability of an operational repository. Legislation is required in 1979 to implement this plan.

At the present time, two alternative planning strategies are considered the most likely to be selected for the construction of a Federal repository for HLW following completion of the GEIS. Both assume disposal in a geologic medium. The primary difference centers on the medium selection process. The alternative which considers a limited range of geologic environments assumes salt for the first repository. A broader range of geological environments and emplacement media would be considered for the first repository, should it be delayed as well as for subsequent repositories. The earliest date for operation of the first repository under this case is 1988.

The alternative which considers a broader range of geologic environments does not give preferential consideration to salt, but rather, all media will be given equal consideration for the first repository. This requires that site selection be delayed until alternative geologic media can be developed to the point where they can receive equal consideration for the first repository. The earliest possible operation of the first repository under this case is 1992. A summary of the key events identified in the High Level Waste Work Plan is presented in Exhibit V-3.

Transuranic (TRU) Wastes

Objectives

The objective of this effort is to accomplish the development, design, construction, and operation of a licensed, geologic repository for the permanent disposal of TRU wastes consistent with applicable safety and environmental requirements. This includes interim storage operations plus the construction of a facility to process the waste compatible with Federal repository acceptance criteria.

Strategy

EPA is developing general environmental protection criteria applicable to all radioactive wastes, which will provide basic criteria to be satisfied by waste systems. These will be available in 1979 and will provide an interim basis upon which NRC can proceed with the development of regulations and DOE can continue on-going operations. EPA will issue specific, numerical environmental standards for disposal of stable form and other forms in 1979 and 1982, respectively. NRC is developing and will propose waste classification system in 1979, which will include a limit on the concentrations of TRU wastes that can be disposed of by shallow land burial. NRC will issue TRU disposal regulations in 1980.

DOE will continue to package and retrievably store TRU wastes in conformance with internal DOE standards until the required capability for processing and disposal is established (1986). As formal EPA and NRC criteria and standards are promulgated, site operations will be modified to achieve compliance or conformance. DOE will establish utilization plans for all nuclear sites in 1979 which will identify the intended future use of present and proposed new locations. By 1982, DOE will complete environmental studies which will evaluate the options and impacts of disposing of all TRU wastes.

It is proposed that a licensed repository for permanent disposal of TRU wastes generated by the DOE defense program be constructed in a salt medium. The EIS being prepared on the proposed site near Carlsbad, New Mexico will be completed by 1979 and analyze the processing and disposal of the TRU wastes currently stored at the DOE site in Idaho. Assuming that the NEPA process results in the acceptability of the Carlsbad site, the earliest possible date for operation of the respository is 1986. Should the proposed site be found unacceptable, repository startup would be delayed a minimum of 2 years. Legislation authorizing NRC to license a TRU repository for defense wastes will be prepared and submitted to Congress in 1979.

A TRU reprocessing facility at Idaho has been proposed which would be available in 1987 to process TRU wastes to a stable form compatible with waste acceptance criteria established for the TRU Federal repository. A transportation system for the safe shipment of wastes between waste generation, processing and disposal facilities is required to support their operations. DOE is working to assure the timely availability of adequate hardware and systems to support these activities. A summary of the key events identified in the Transuranic Wastes Work Plan is presented in Exhibit V-4.

Low Level Waste

Objectives

The objectives of this work plan are to: (1) develop and promulgate the necessary criteria, standards, and regulations for the safe disposal of LLW; (2) define the roles and responsibilities of the Federal agencies, States, and private industry in disposal of LLW from the government and private sector; and (3) to implement programs to assure that an adequate number of regional LLW disposal sites are available to meet disposal needs.

Strategy

The EPA is currently developing guidance applicable to all forms of radioactive waste management. These General Environmental Criteria will include coverage for LLW management activities. This work will culminate in the issuance of a specific standard for shallow land burial of LLW by 1983. EPA will also establish a development program to obtain data upon which to base specific criteria and standards for LLW disposal in the sea.

NRC will develop a system to classify radioactive wastes according to the type and duration of confinement required for their safe disposal. Regulations will be modified, as necessary, when definitive EPA standards are promulgated. NRC's program also provides for identification and evaluation of alternative LLW disposal methods, and will include the development of a regulatory program for at least one alternative disposal method other than shallow land burial. These programs will include full public participation and application of NEPA requirements. The States, through the NRC Agreement State program, will implement regulations and criteria similar to those promulgated by the NRC, in connection with the renewal of existing licenses for current commercial burial facilities or the review and approval of new commercial burial ground applications.

DOE will establish internal interim and final operating criteria for its shallow land burial operations in 1978 and 1980, respectively. DOE burial sites will be brought into conformance with these criteria by 1980 and 1987, respectively.

DOE will participate with NRC in the development of future LLW waste projection estimates by 1979. This will be followed by a DOE and NRC study on disposal methods and the number, type, and general locations for land disposal sites to be completed by 1980.

Environmental assessments and/or impact statements will be prepared to evaluate the risk and options for existing and future burial grounds operations at all DOE facilities by 1980. These documents will help identify the alternatives which warrant further review and development.

Legislation will be prepared by DOE in consultation with NRC and submitted to the Congress in 1979 providing the option and resources for transferring ownership of commercial burial ground operations to the Federal Government.

A summary of the key events identified in the Low Level Waste Work Plan is presented in Exhibit V-5.

Uranium Mill Tailings

Objective

The objective of agency programs in this area is to assure that uranium mill tailing wastes are disposed of in such a manner that emissions of radon and other radioactive elements are reduced to or as near background levels as can reasonably be achieved, with no active institutional care required to preclude personal exposures.

Strategy

EPA will issue interim environmental standards and criteria in 1979 required to enable NRC and DOE to develop necessary regulations and procedures to implement the standards. EPA will develop formal specific standards (numerical) covering mill tailings disposal by 1985 after additional research on tailings disposal is completed and some actual tailings stabilization work is carried out at currently inactive sites. NRC has issued interim criteria on tailings disposal to facilitate the continued licensing of new operations and the renewal of existing licenses pending completion of formal regulations and criteria. NRC is preparing a generic environmental impact statement (GEIS) on uranium milling to be issued in 1979. Formal regulations covering mill tailings will be developed and issues in connection with this GEIS.

DOE has completed an initial engineering assessment of inactive mill tailings sites. This served as a basis for the legislation now pending before Congress, to assign responsibility and necessary resources to DOE for appropriate remedial action at inactive mill tailings sites. This legislation would classify radon and radium in mill tailings as a "by product" material, thereby making tailings subject to NRC authority. It also provides for the establishment of appropriate standards by EPA and the enforcement of the standards by NRC. Recommendations for Federal and State cooperation are also included in the proposal. A summary of the key events identified in the Uranium Mill Tailings Work Plan is presented in Exhibit V-6.

Decommissioning

Objectives

The Federal government will develop the necessary criteria, standards and regulations requried for the decommissioning of nuclear power reactors, associated facilities, and DOE facilities and sites at an appropriate time following the completion of beneficial use.

This decommissioning will be performed to assure the protection of the public health and safety and to permit the maximum release of facilities and lands for unrestricted use or restricted use under specified conditions. The EPA, NRC, and DOE will coordinate their activities and interact with the Congress, states, and public to implement appropriate programs. Radioactively contaminated waste resulting from the decontamination and decommissioning (D/D) actions is not a unique class of waste and disposal will be handled as part of the regular waste management programs.

Strategy

In 1979, EPA will issue generally applicable environmental standards and criteria and NRC and DOE will develop necessary regulations and procedures. The development of residual activity standards by 1981 is the pacing activity, since they will provide the limits or guidelines for: (1) unrestricted release of facilities, equipment and sites; (2) criteria for allowing restricted release of facilities; and (3) criteria for determining remedial action.

By 1979, DOE will complete preparation of site utilization plans, which will provide a basis for future decisions on facility use and identify surpluse facilities requiring D/D. This plan will prioritize DOE facilities for D/D according to risk factors. This plan will be updated annually. This plan will highlight high priority projects for D/D with final decisions based on economic, environmental and programmatic factors.

Legislation is required to:

1. Assign reponsibility for providing long term surveillance of decommissioned facilities on sites not released for unrestricted use.

2. Assign responsibility for remedial action at abandoned sites which do not meet current standards for unrestricted use.

A summary of the key events identified in the Decommissioning Work Plan is presented in Exhibit V-7.

Transportation

Objective

The objective of efforts related to transportation is to assure the availability of adequate transportation systems for the safe shipment of spent fuel and other radioactive waste materials.

Strategy

DOE will develop a statistical data base of relevant information on shipment and accident experience involving radioactive waste transportation to improve risk assessments, evaluate transportation adequacy, and serve as a public information reference source.

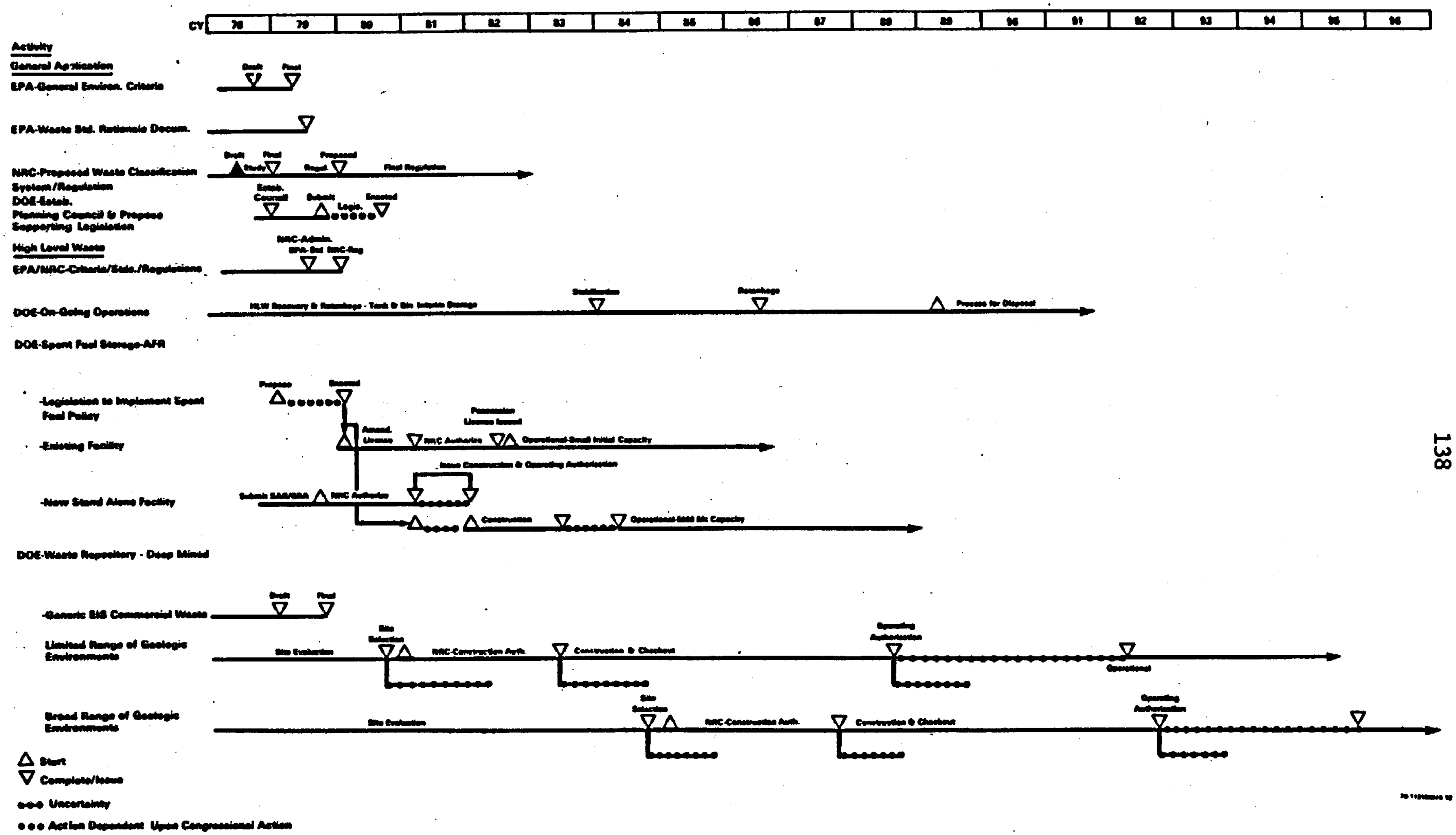
Institutitonal relationships among Federal, State and local agencies will be refined to provide a decision-making framework for transportation regulations. A DOT public rulemaking procedure to examine mechanisms for establishment of highway routing of radioactive materials will be completed by 1980. The Federal role in emergency preparedness and response actions to transportation accidents involving radioactive wastes will be expanded. Primary responsibility for such activity is being centralized within DOT. The State Department and NRC will examine liability questions related to U.S. acceptance and transport of foreign owned spent fuel, and prepare legislation is required.

DOE will develop and conduct a coordinated program for evaluating the performance of current and future generations of packaging systems during accident conditions. This would involve other Federal agencies and the nuclear and transportation industries. For transuranic (TRU) wastes, DOE will assure the existence of adequate operational hardware and transportation systems and test prototype hardware by 1983. U.S. industry will be relied upon to provide hardware for spent fuel transport, on a schedule consistent with projected needs for shipment to AFR's and to geologic repositories.

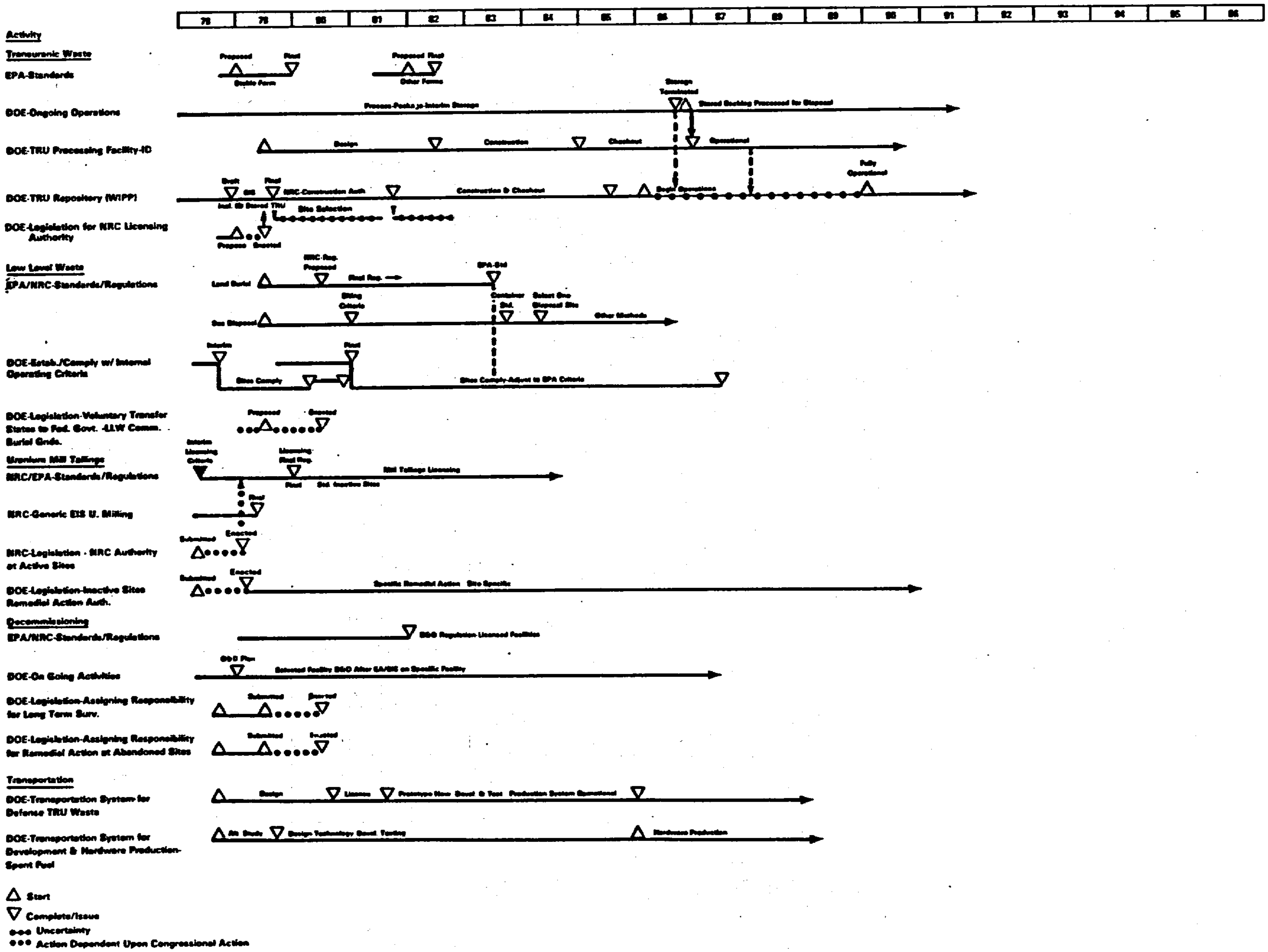
DOE will maintain surveillance of the design, licensing, fabrication and testing program to ensure progress and satisfactory completion.

A summary of the key events identified in the Transportation Work Plan is presented in Exhibit V-8.

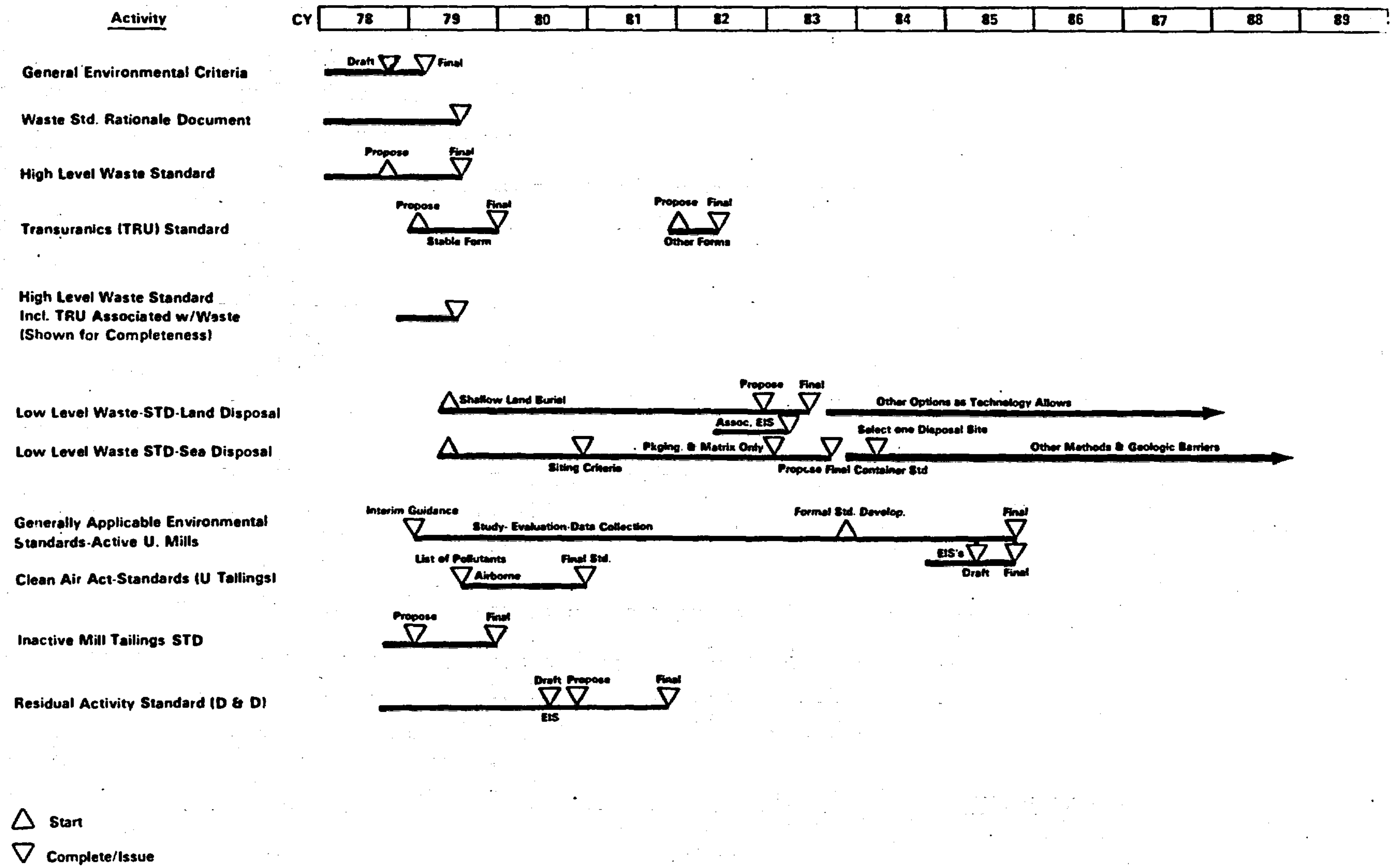
Work Plan Summary
Exhibit V-I
Part 1



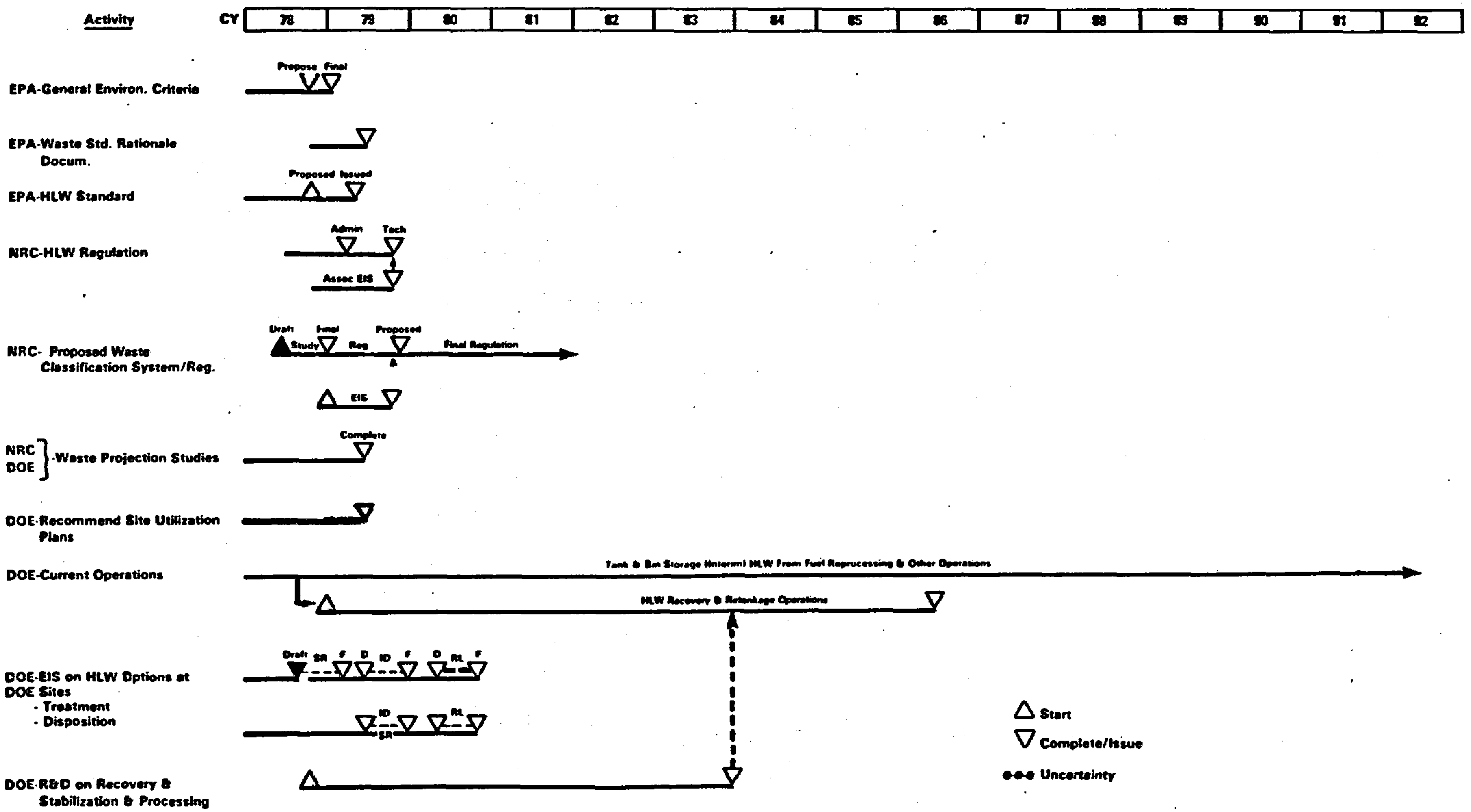
Work Plan Summary
Exhibit V-1
Part 2



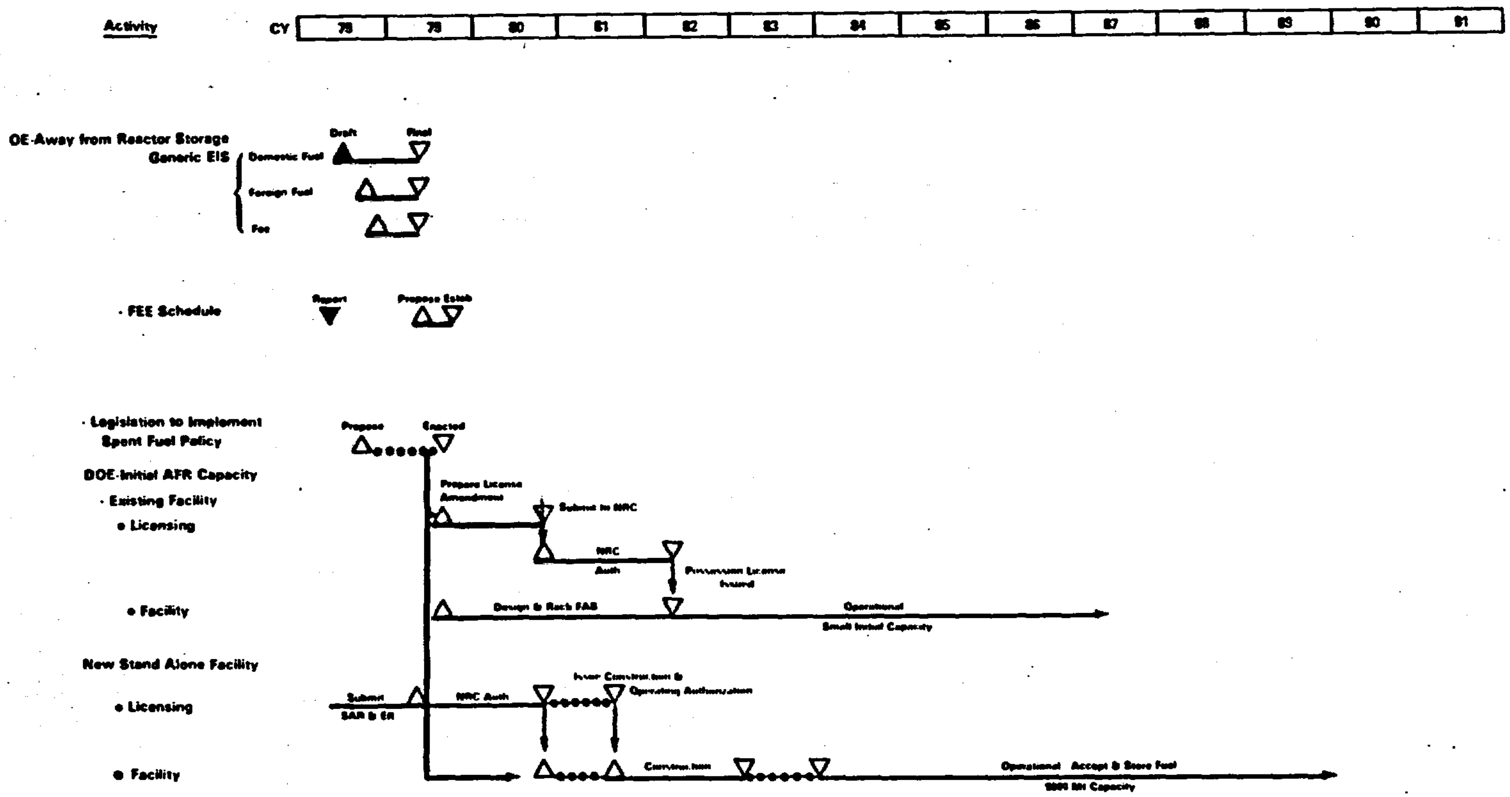
Work Plan for EPA Criteria & Standards
Exhibit V-2



Work Plan for High Level Waste Exhibit V-3 Part 1

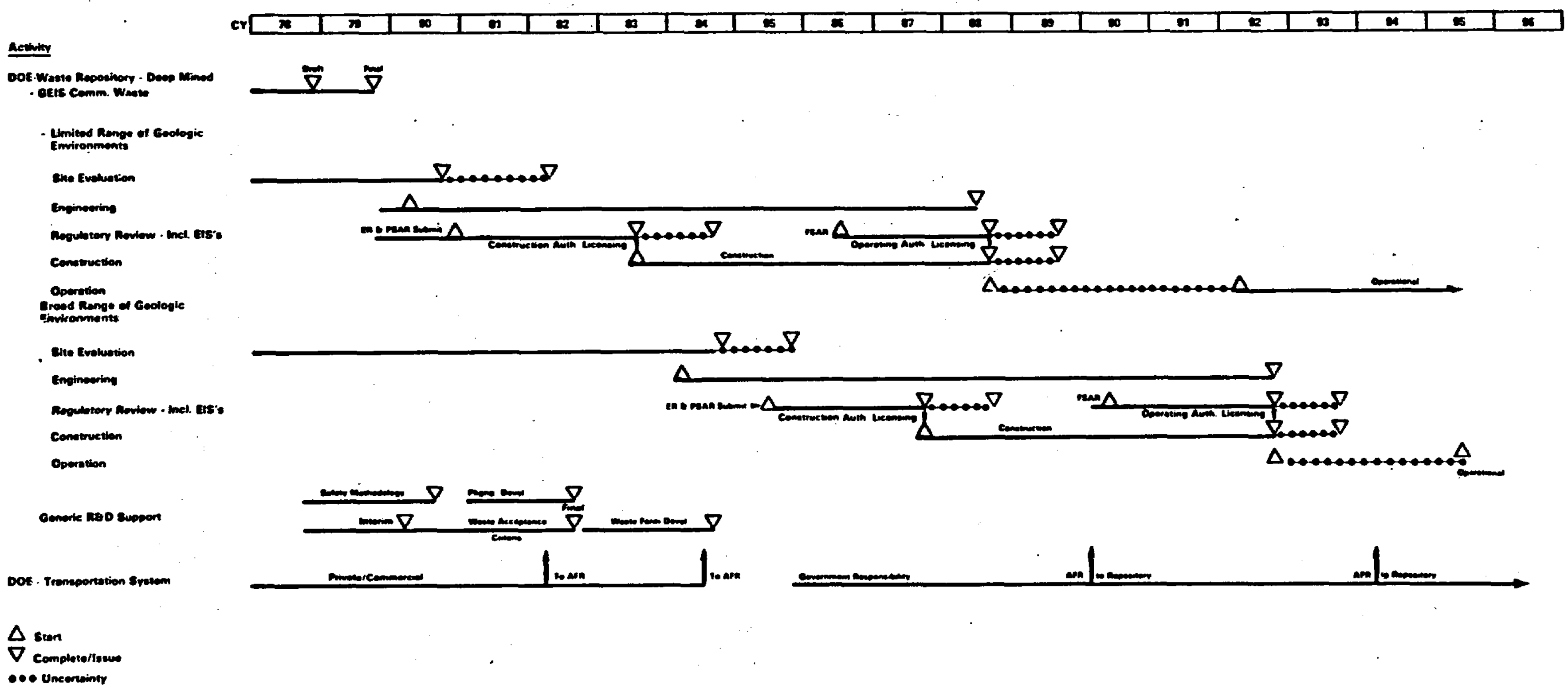


Work Plan for High Level Waste
Exhibit V-3
Part 2

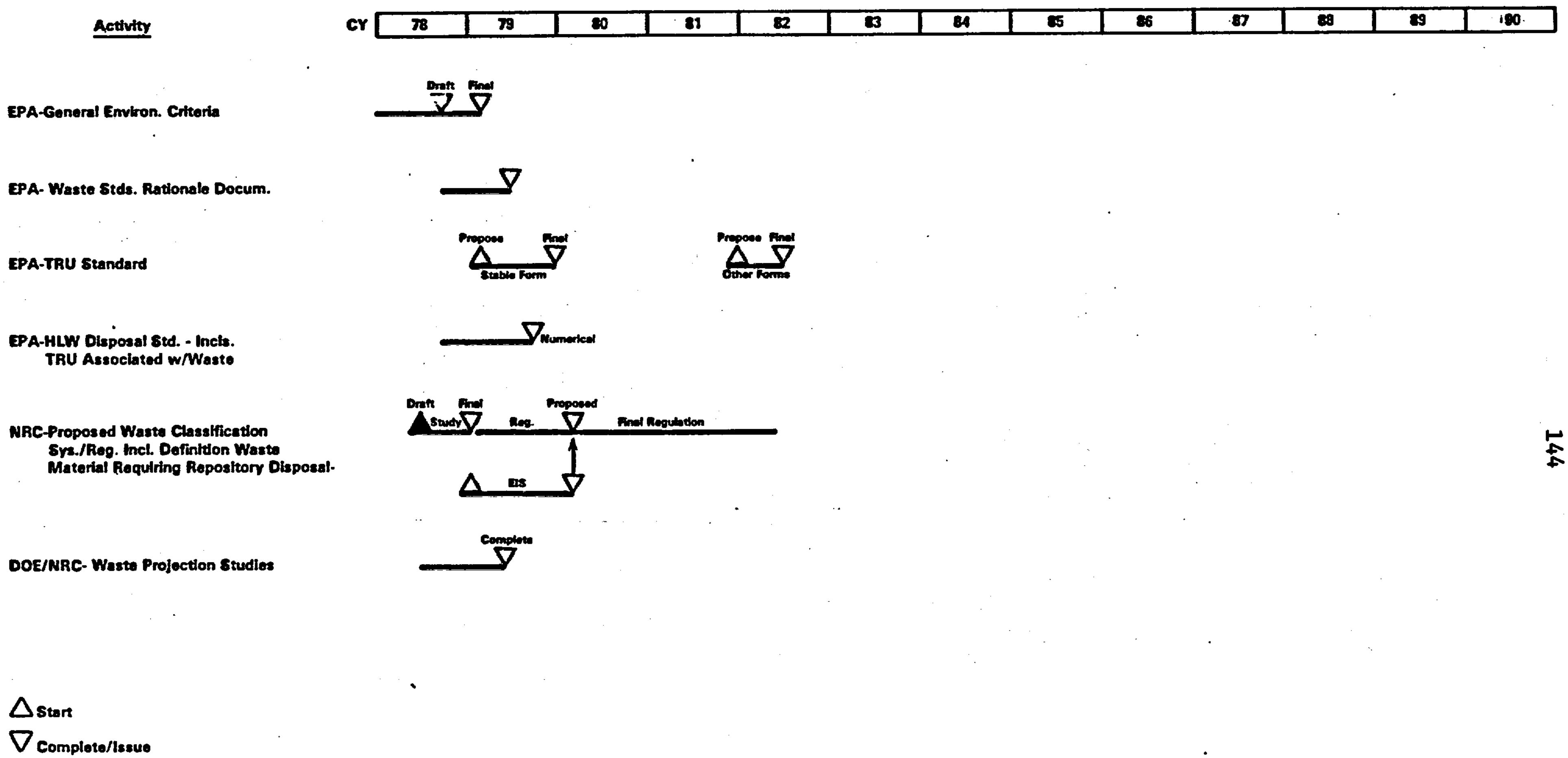


△ Start
▽ Complete/Issue
●-●-● Uncertainty
●●● Timing Dependent Upon
Congressional Action

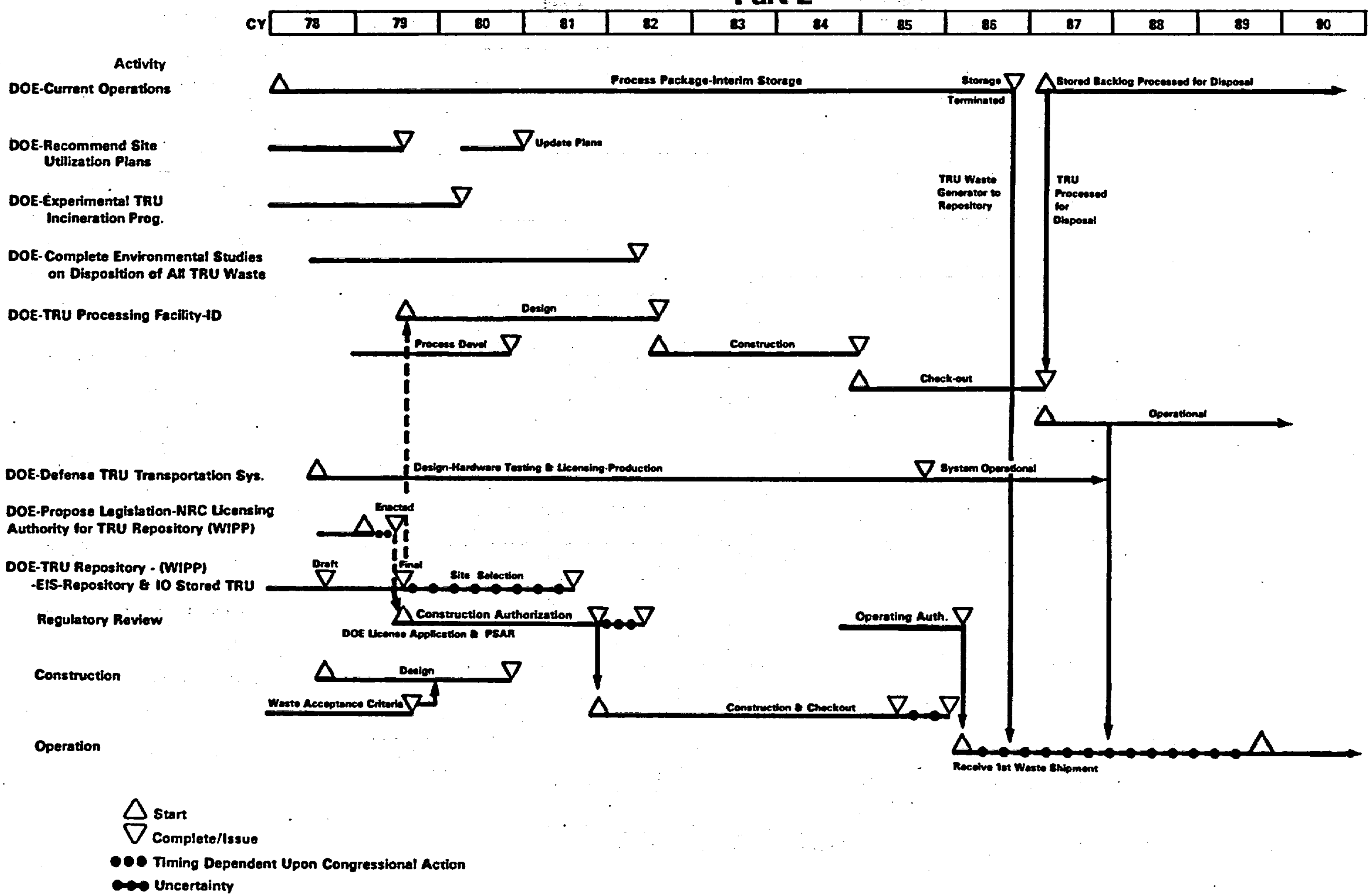
Work Plan for High Level Waste
Exhibit V-3
Part 3



Work Plan for Transuranic Waste Exhibit V-4
Part I



Work Plan for Transuranic Waste
Exhibit V-4
Part 2



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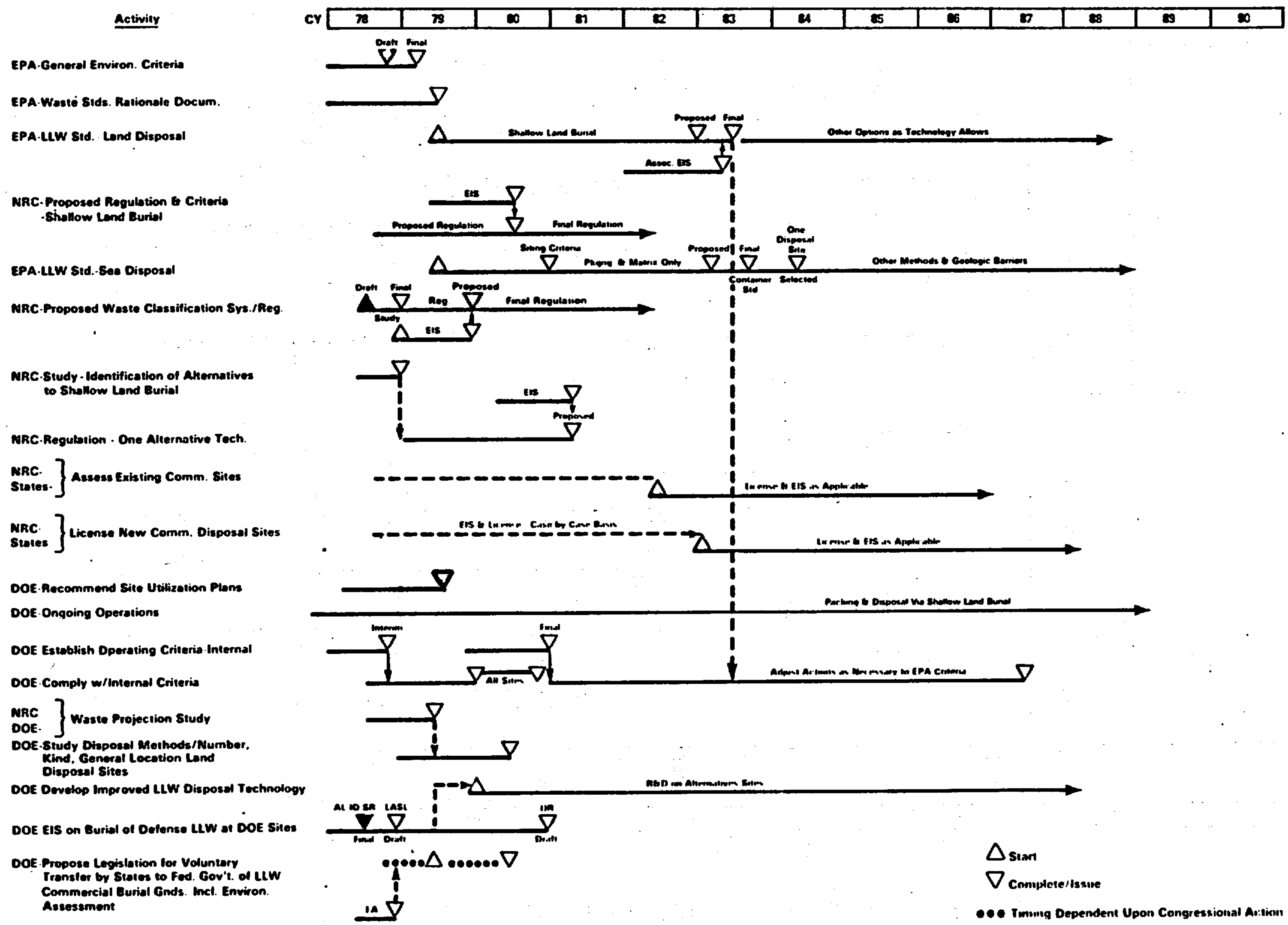
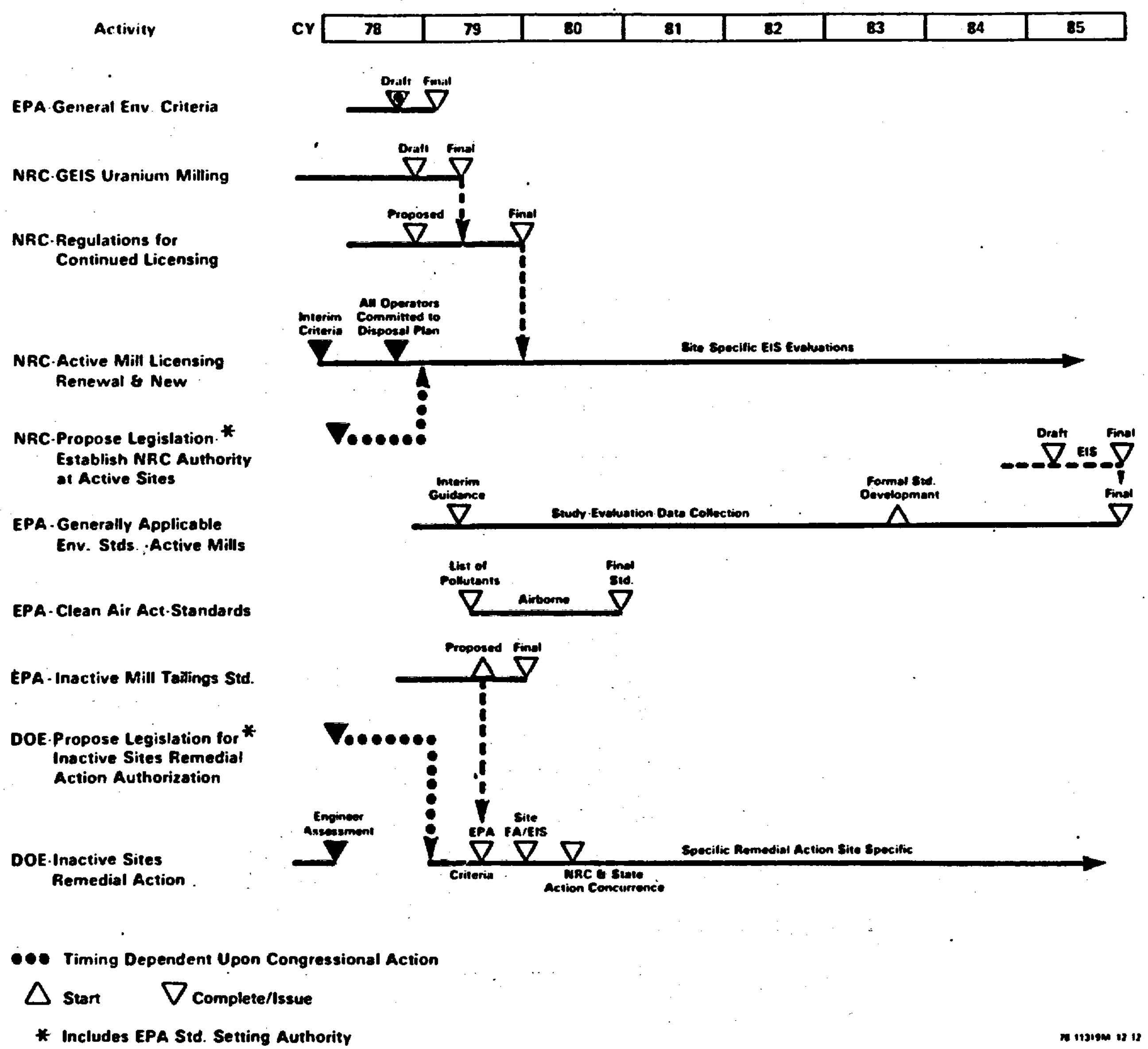
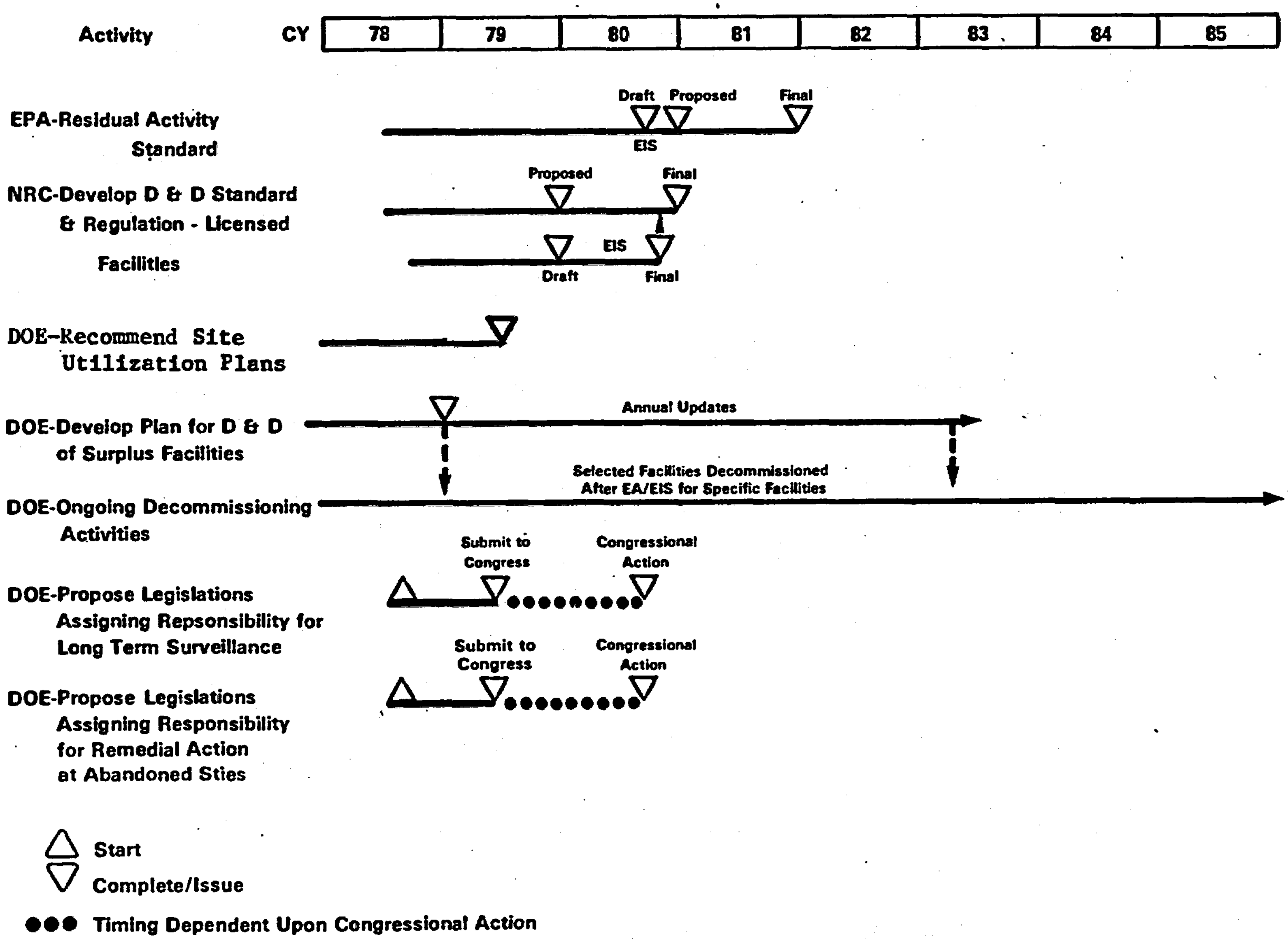
Work Plan for Low Level Waste Exhibit V-5



Work Plan for Urnaium Mill Tailings Exhibit V-6

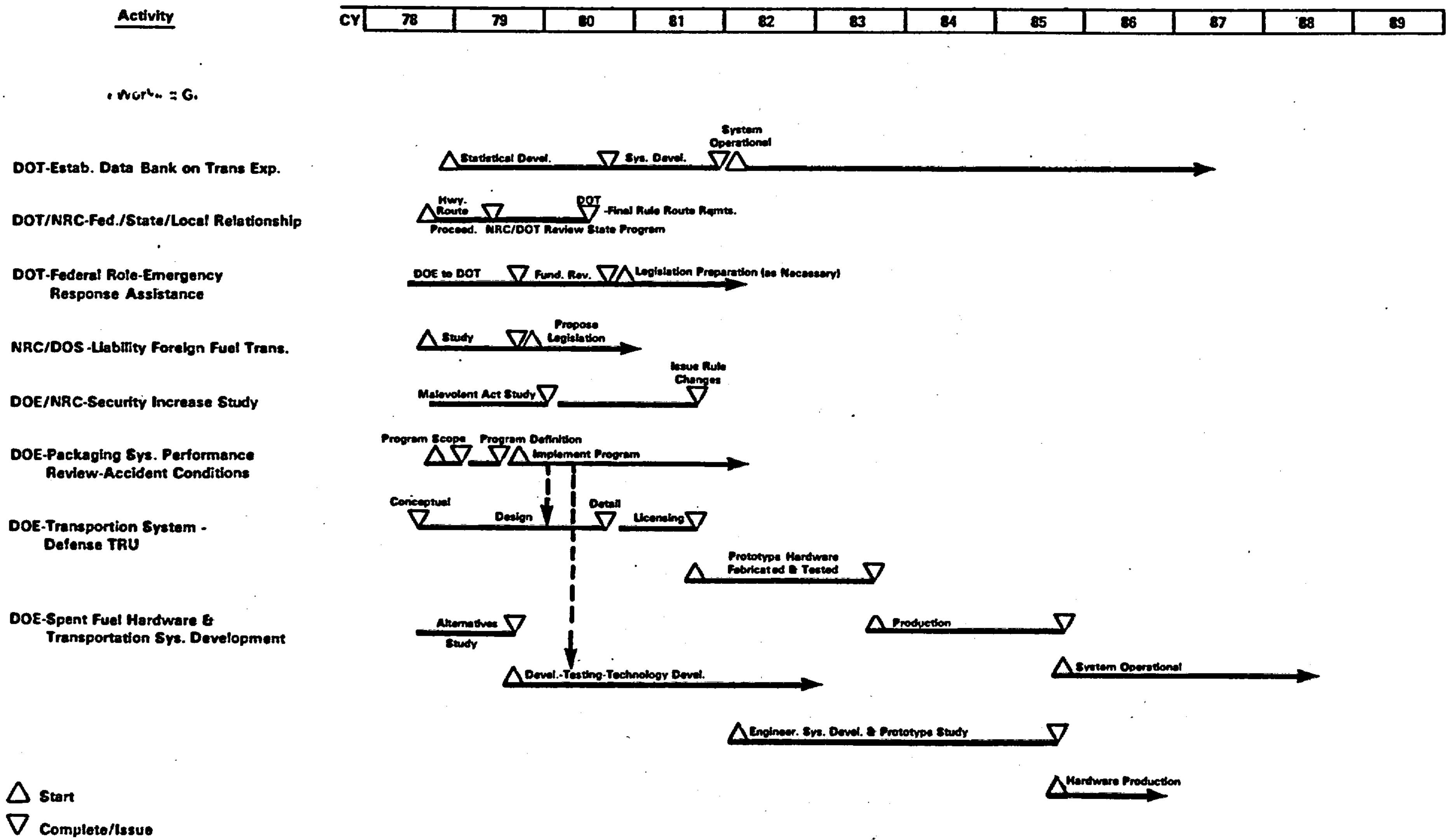


Work Plan for Decommissioning
Exhibit IV-7



78-11319M/9-12

Work Plan for Transportation
Exhibit V-8



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APPENDICES

APPENDIX A

THE WHITE HOUSE

WASHINGTON

March 13, 1978

MEMORANDUM FOR THE SECRETARY OF STATE
THE SECRETARY OF THE INTERIOR
THE SECRETARY OF TRANSPORTATION
THE SECRETARY OF ENERGY
CHAIRMAN, COUNCIL ON ENVIRONMENTAL QUALITY
ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY
ACTING DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET
DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY
ASSISTANT TO THE PRESIDENT FOR DOMESTIC AFFAIRS AND POLICY
ASSISTANT TO THE PRESIDENT FOR NATIONAL SECURITY AFFAIRS

SUBJECT: Interagency Nuclear Waste Management Task Force

By this memorandum I am establishing an interagency Nuclear Waste Management Task Force to formulate recommendations for establishment of an Administration policy with respect to long-term management of nuclear wastes and supporting programs to implement this policy. I have asked the Secretary of Energy to chair this Task Force.

The Department of Energy is issuing a draft report setting forth preliminary views on key issues in the waste management area. This report should serve as the basis of initial discussion for the Task Force. Areas which should be considered, leading to establishment of an Administration policy for nuclear waste management, include wastes from commercial nuclear power operations, existing low-level, transuranic (TRU), and high-level defense wastes. In addition, on-going programs should be reviewed to assure that the policy is implemented in a timely manner. Attention should also be given to the necessity of legislation, environmental assessment, support for our non-proliferation objectives, and budgetary impacts including potential involvement in waste management programs by private industry.

The deliberations of the Task Force should include opportunity for appropriate participation by the interested public, industry, States, and Members of Congress.

I am directing that the activities of the Task Force be initiated by March 15 and final recommendations should be completed by October 1, 1978.

Jimmy Carter

APPENDIX B

MEMBERS OF INTERAGENCY REVIEW GROUP

MEMBER	DEPARTMENT
Sam Bleicher	DOC
Eliot Cutler	OMB
Joan Davenport	DOI
John M. Deutch	DOE
David Hawkins	EPA
James Kramer	NASA
Jessica Tuchmen Mathews	NSC
Joseph Nye	DOS
Lee Santman	DOT
Katherine P. Schirmer	Domestic Policy
Clifford Smith	NRC
Philip Smith	OSTP
Gus Speth	CEQ
Charles Van Doren	ACDA

APPENDIX C

PUBLIC INTERACTION

The IRG stressed the importance of obtaining a broad range of viewpoints in developing its recommendatins. It fully endorses the view expressed in the DOE Task Force report that, "A successful nuclear material waste management policy must reflect the views of other government agencies, Congress, States, industry, and the concerned public, in addition to those of the Department of Energy. Only with a broad understanding and acceptance of this policy can a program be successfully developed and implemented that will satisfy public concerns." The IRG clearly believes that significanly more needs to be done in this area. Appropriate recommendations are contained in the Report.

The Process

Although the time available was limited, an interactive process was attempted. Sources of public input included:

- o Consideration of a wide range of prior studies and analyses of the waste management situation by such diverse and knowledgeable oraganizations as the National Academy of Sciences, the U.S. Geological Survey, the American Physical Society and the California Energy Resources Commission.

- o Distribution of over 8,000 copies of the draft DOE report of the Task Force for Review of Nuclear Waste Management leading to the receipt of a large volume of correspondence and comment on its contents.

- o Meetings and discussions, during the early phases of the IRG with individuals and groups representing a large spectrum of opinion, based largely on the draft DOE report and the Appendix A of the Subgroup I Report.

- o Appearances before Congress of IRG representatives, in their regular agency roles, presenting testimony and addressing Congressional questions and concerns on waste management and related issues.

- o Interaction with staff and principals of the Nuclear Subcommittee of the National Governors' Association.

- o Seven DOE-sponsored public meetings in New Mexico and Texas, concerning the proposed Waste Isolation Pilot Plant, but inevitably leading to discussion of issues of broader concern including the safety of geologic disposal per se, Federal/State interaction processes, liability issues, nuclear moratoria, nonproliferation policies, etc.

- o Small Group Meetings during early July, open to the public, discussing the overall approach of the IRG and perceived issues and alternatives under consideration by the IRG.

- o Three major Regional Public Meetings in San Francisco, Denver and Boston during late July and early August, each with significant attendance by IRG principals and their direct representatives, to receive a broad base of comment and recommendation from interested citizens and organizations. Citizen concerns reflected a broad range of issues comparable to those raised in the public metings in New Mexico and Texas.

- o Distribution of material in connection with the above Small Group and Regional Public Meetings describing the organization and approach of the IRG and presenting its early draft state-of-the-art report on technical issues of geologic disposal for public comment.

- o The involvement of a Technical Advisory Committee covering diverse viewpoints to review and assist in the preparation of material on technical issues of disposal techniques and the identification and analysis of four major alternative technology strategies for disposal of HLW and TRU waste.

- o Nearly 200 letters of response from the technical community on the draft state-of-the-art report referred to above.

- o Publication for comment of the draft reports of six staff subgroups of the IRG analyzing the majority of issues treated in more summary fashion in this report.

- o Publication for comment of this draft report of the IRG principals prior to reaching their final views on appropriate recommendations to be forwarded to the President.

The Results

The results of the three major public input elements, a series of small group meetings in Washington, DC, three large Public Meetings, and an opportunity for the public to submit written comments or testimony on the IRG activities, are summarized below.

The total elapsed time from the initial press release on June 30, 1978, until the last day of the third Public Meeting (in Boston) on August 5, 1978, was 37 days. Nevertheless, response to press announcements, individually mailed invitations, and a Federal Register Notice (on July 17, 1978) was rapid and vocal. As indicated in Table C-1, a total of 729 people participated in the process, 220 as speakers at one of the three meetings, 365 as non-speaking attendees, and 144 who submitted written testimony. In addition, this testimony represented 39 states and the District of Columbia as shown in Table C-3.

Three Public Meetings

Citizens at the large public meetings expressed a desire to be heard and for the government to listen. They appreciated the opportunity for public participation, but many felt that the process was nothing more than window dressing--a charade--in view of the short timeframe identified for comment. Despite repeated Federal panel member apologies and explanations (especially at the San Francisco and Denver meetings) public comment often used the "lateness of meeting announcement" issue as an example of Federal resolve to prevent specific citizen groups from testifying.

Much of the comment heard at the meetings went beyond the specific issues being considered by the IRG. As indicated in Table C-2, the sentiments heard most often were basically anti nuclear. Twenty-one percent of the speakers requested moratorium on continued nuclear waste generation and weapons production. Twenty-five percent requested a cessation of all future nuclear development, and 29 percent questioned the credibility of the government on the whole nuclear waste issue. On the other hand, only 14 percent agreed with the findings of the DOE Task Force Report.

Tables C-4A, C-4B, C-5A, and C-5B categorize further the testimony received at the meetings by IRG subgroup or other specific issue, speaker affiliation, and meeting location. Representation by individual citizens and consumer/special interest groups was very high followed by State/local government and the academic community. Some 53 percent of the speakers also used the meeting as an opportunity to speak on such other issues as anti or pro-nuclear sentiment, alternative energy sources, or the public participation process.

All three meetings experienced periods of public tenseness, displeasure and hostility toward the Federal panel assembled. However, the three sessions also developed into candid, respectful dialogues between attendees and panel members. Personal fears and strongly held views, while not dispelled, fell second to allowing the public process to work. In addition, on-going discussions of issues and further review of subsequent IRG reports were promised as proof of the Government's intent to accommodate differing and conflicting views.

Small Group Meetings

The small group meetings in Washington, DC were intended to create a dialogue between Federal officials and selected citizens regarding special interests, concerns, and/or recommendations for a national nuclear waste management policy. Individual meetings were held with representatives of the following groups:

U.S. Senate Staff
U.S. House of Representatives Staff
State Governors
State Legislators

City and County Officials
Indian Tribes
Utilities
Industry
Transportation
Scientific Community

In general, the meetings, similar to the three larger Public Meetings, produced discussion primarily centered on the lack of government credibility and public acceptance, and the problem of public misconceptions and misunderstandings regarding nuclear waste. Federal attendees sought recommendations on better ways to implement public information programs and mechanisms for improved interactions with regional, state, and local jurisdictions. Specific concerns were raised at all meetings, regarding the proposed Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, and the various federal activities regarding WIPP that have occurred to date. Similarly, transportation related issues and the financing of nuclear waste activities were common subjects discussed at most sessions.

Written Testimony

The IRG request for submission of written statements generated 144 peices of testimony. The written testimony issue areas are referenced in Tables C-1, C-2, C-3, C-4A, C-4B, C-5A, and C-5B.

Written comments received were just as divergent as those presented orally at the three meetings, although they contained a distinct technical and acadamic flavor. Twenty-four percent of the testimony requested a moratorium on continued nuclear waste generation, and 21 percent requested a cessation of all future nuclear development including weapons production. Seventeen percent agreed with the findings of the DOE Task Force Report. Even more enlightening, however, 42 percent of those individuals submitting written testimony requested and expansion in the overall public participation process in the development of government policy. Sixty-four pieces of testimony, representing 44 percent of the total received, contained definite anti-nuclear comments. Ninety-five pieces of testimony, representing 65 percent of the total received, were directly related to the six IRG subgroups.

TABLE C-1

INTERAGENCY REVIEW GROUP
ON NUCLEAR WASTE MANAGEMENT

SUMMARY OF PUBLIC PARTICIPATION

Public Meetings	Speakers	Other Attendees	Total
San Francisco	61	69	130
Denver	53	111	164
Boston	106	185	291
Written Testimony			144
	Total Participation		729

TABLE C-2

INTERAGENCY REVIEW GROUP
ON NUCLEAR WASTE MANAGEMENT

RECURRING THEMES DIRECTED TO THE IRG

	Public Meetings					
	San Francisco	Denver	Boston	Written Testimony	Total	Percent of Total Audience
1. The IRG and DOE should sponsor nationwide TV debates on nucler waste management issues.	--	7	6	13	26	3.5
2. Impose an immediate moratorium of the generation of nuclear waste until an effective disposal method is developed.	9	10	29	35	83	11.3
3. Expand the overall public participation process in the development of government policy.	18	9	30	61	118	16.1
4. Cease all future nuclear activity-military and commercial-and dismantle the entire nuclear apparatus.	12	12	33	30	87	11.9
5. Agree with conclusions in the Deutch Report.	9	5	17	7	38	5.2
6. Disagree with conclusions in the Deutch Report.	8	8	18	10	44	6.0
7. Questions the Federal government's credibility on nuclear waste management and other national issues.	21	18	27	25	91	12.4

TABLE C-3

TESTIMONY RECEIVED - BY STATE

	Oral	Written		Oral	Written
Arizona	2	3	Minnesota	0	2
California	57	15	Missouri	2	5
Colórado	36	7	Nevada	1	0
Connecticut	4	3	New Hampshire	7	3
Delaware	1	0	New Jersey	4	1
District of Columbia	5	3	New Mexico	8	7
Florida	3	1	New York	10	12
Georgia	1	2	North Carolina	2	0
Hawaii	1	0	Ohio	1	7
Idaho	0	2	Oregon	1	2
Illinois	1	5	Pennsylvania	2	6
Indiana	0	1	Rhode Island	4	1
Iowa	2	3	South Carolina	5	1
Kansas	0	3	South Dakota	0	1
Kentucky	0	1	Tennessee	4	4
Louisiana	1	1	Texas	2	10
Maine	1	1	Vermont	2	0
Maryland	2	1	Washington	1	9
Massachusetts	41	11	West Virginia	0	1
Michigan	0	8	Wisconsin	0	1

TABLE C-4A

INTERAGENCY REVIEW GROUP
ON NUCLEAR WASTE MANAGEMENT

TESTIMONY RECEIVED - IRG SUBGROUP BY AFFILIATION

	Alternative Technology Strategies	Federal Involvement	Defense Wastes	Spent Fuel From Commercial Reactors	Transportation	International	Total
Academic	19	30	3	8	3	7	70
Citizen	43	40	6	7	14	10	120
Construction	3	2	0	0	0	0	5
Consumer	4	7	1	2	4	1	19
Federal Government	3	2	0	2	0	0	7
Federal Legislators	1	2	0	1	0	0	4
Financial	0	0	0	0	0	0	0
General Business/ Industry	5	5	2	2	1	1	16
Labor Union	0	2	1	0	0	0	3
Nuclear Industry	9	11	2	3	3	0	28
Special Interest Group	36	42	2	11	8	8	107
State/Local Government	10	11	1	1	3	0	26
Utilities	7	9	0	5	3	0	24
Total	140	163	18	42	39	27	429

TABLE C-4B

INTERAGENCY REVIEW GROUP
ON NUCLEAR WASTE MANAGEMENT

TESTIMONY RECEIVED - IRG SUBGROUP BY MEETING LOCATION

	San Francisco	Denver	Boston	Written Testimony	Total
Alternative Technology Strategies	32	13	52	42	139
Federal Involvement	38	22	43	63	166
Defense Wastes	2	3	9	5	19
Spent Fuel From Commercial Reactors	8	1	14	18	41
Transportation	6	1	16	18	41
International	5	0	9	9	23
Total	91	40	143	155	429

TABLE C-5A

INTERAGENCY REVIEW GROUP
ON NUCLEAR WASTE MANAGEMENT

TESTIMONY RECEIVED - OTHER SPECIFIC ISSUES BY AFFILIATION

	Anti-Nuclear Comments	Comments on the Meetings	Alternative Energy Sources	Pro-Nuclear Comments	Total
Academic	12	7	4	9	32
Citizen	77	20	17	12	128
Construction	1	0	0	1	2
Consumer	7	6	2	2	17
Federal Government	1	2	0	1	4
Federal Legislators	0	1	1	0	2
Financial	0	0	0	0	0
General Business/Industry	1	1	1	3	6
Labor Unions	3	0	1	1	5
Nuclear Industry	0	0	0	6	6
Special Interest Group	49	16	16	12	93
State/Local Government	6	1	1	1	9
Utilities	2	1	1	5	9
Total	159	55	46	53	313

TABLE C-5B

INTERAGENCY REVIEW GROUP
ON NUCLEAR WASTE MANAGEMENT

TESTIMONY RECEIVED - OTHER SPECIFIC ISSUES BY MEETING LOCATION

	Boston	Denver	San Francisco	Written Testimony	Total
Anti-Nuclear Comments	47	31	21	60	159
Comments on the Meetings	14	6	3	32	55
Alternate Energy Sources	17	1	4	24	46
Pro-Nuclear Comments	7	6	15	25	53
Total	85	44	43	141	313

Appendix D

Scope and Magnitude of Waste Management

I. INTRODUCTION

The term "waste management" encompasses a complex system comprised of numerous types, sources and dispositions of radioactive waste and the processing and transportation required to move them from their point of generation to disposal. To facilitate the understanding of waste management as a system, two basic cases are defined and analyzed.

These cases are, admittedly, two extremes. This is not to imply that all the assumptions for each case are extreme and, by implication, unrealistic. Rather, the composite effects of individual assumptions for each yield results which delineate broad boundaries for the whole waste management system.

II. CASE DESCRIPTIONS

The first case reflects a geographically centralized waste management system. Case 1 is designed to minimize the need for LLW (low level waste) burial ground acreage and the need and number of geologic repositories for TRU (transuranic) waste, HLW (high level wastes), and spent fuel. This is accomplished through assumptions which reflect low nuclear capacity levels, volume reduction techniques for LLW and TRU, small-scale decontamination and decommissioning (D&D) programs for commercial and DOE facilities, and minimization of material sent to a single TRU waste repository.

The second case describes a larger, more decentralized waste management system. Case 2 is structured to maximize burial ground needs and the need and number of repositories (DOE and commercial) by assuming significant nuclear growth consistent with the National Energy Plan (NEP), no volume reduction for LLW and TRU, a moderate scale D&D program, and more technically conservative repository design assumptions.

The following discussion focuses on the forms and quantities of radioactive wastes to be handled and the requirements for transporting and disposing of them. Table 1 summarizes the assumptions used in each case. Assumptions about nuclear power and repository design which apply throughout the appendix are discussed below. Other assumptions are presented in the appropriate section.

Table 2 presents annual spent fuel and waste generation rates for an average 1000 MWe reactor (1/3 BWR, 2/3 PWR) and associated fuel cycle activities, assuming a "once through" fuel cycle (no reprocessing), an average capacity factor of 67 percent, a thermal efficiency of .32, and an average burnup of 25,000 MWD/MTHM. Table 3 summarizes key repository design assumptions for the commercial spent fuel repositories and required DOE repositories.

TABLE 1

CASE DESCRIPTIONS

DESCRIPTION	CASE 1	CASE 2
Nuclear Capacity, Year 2000	148 GWe	380 GWE
Commercial Waste Generation		
o Low Level Waste		
- Reactors		
- Through 1980	a) Past Experience Continues	Past Experience Continues
1981-1985	b) Volume reduced to 1/3 of a)	(all years)
Post-1985	c) Volume reduced to 1/9 of a)	
- Fuel Cycle	(Same annual quantities per reactor for both cases)	
- Non-Fuel Cycle	(Same projection for both cases)	
- D&D to the year 2000	Mothball 5 reactors	Dismantle 5 reactors
o Transuranic Wastes	(Same for both cases)	
DOE Waste Generation		
o Low Level Wastes		
- Operations		
Through 1985 Post-1985	No volume reduction Volume reduced to 1/5	No volume reduction (all years)
- D&D to the year 2000	10 million cubic feet	160 million cubic feet
- Other	Decontaminated salt	none
o Transuranic Wastes		
- Operations	Volume reduced to 1/5 after 1985	No volume reduction
- D&D to the year 2000	5 million cubic feet	95 million cubic feet
- Exhumation of buried TRU	No	Yes

Table 1 (continued)

	CASE 1	CASE 2
o High Level Wastes		
- Savannah River (Decontaminate salt cake and vitrify the balance)	1. Salt cake to LLW burial 2. Balance to a geologic repository	All waste sent to a geologic repository
- Idaho (calcine or vitrified calcine)	Entomb on-site	Ship to a geologic repository
- Richland (same as Savannah River)	1. Salt cake to LLW burial 2. Balance to a geologic repository	All waste placed in a basalt repository below site.
- West Valley (NSF)	Vitrify and colocate with DOE HLW	Same as Case 1
o ORNL Intermediate Level Wastes	Inject grout made with waste into hydrofractured shale below site	Same as Case 1

III. LOW LEVEL WASTE (LLW) STORAGE REQUIREMENTS

There are three basic sources of commercial low-level waste: nuclear reactors and associated fuel cycle facilities; non-fuel cycle sources such as industry, academia, and hospitals; and D&D activities. Table 4 projects the quantities of LLW expected from these sources for Case 1.

The model reactor data in Table 2 were used for projecting LLW from reactor and fuel cycle activities. It is assumed for reactor waste that volumes consistent with past experience will continue through 1980, followed by achievement of levels expected when the reactor was designed for 1981-85 and institution of advanced volume reduction techniques thereafter. Low level waste (LLW) from reactor operations consists of contaminated trash, used HEPA filters, ion exchange resins, etc., and is packaged and shipped to commercial burial grounds for disposal. The packaging step increases the volume by a factor of 2. Present operating practices result in volumes which are 3 times what was anticipated during design and about 9 times more than if advanced, though not presently economical, volume reduction techniques were instituted.

LLW is also generated by fuel cycle activities related to the reactor. LLW generated by industrial, academic, medical, and other sources are also not expected to undergo volume reduction because the particular quantities generated by these many small contributors probably preclude economic justification of individual investment in volume reduction facilities. Finally, LLW from D&D activities are assumed not to undergo volume reduction, since much of the material is contaminated equipment.

The quantities of projected LLW under Case 2 assumptions are presented in Table 5.

TABLE 2

ANNUAL WASTE GENERATION RATES
(Normalized to an Average 1000 MWe LWR)

Spent Fuel Discharged (Ave.)	25.4 MT HM/yr (332 ft^3/yr)
Low Level Waste, Generated Onsite 1/	
a) Present Experience	45,000 ft^3/yr
b) Design Basis	15,000 ft^3/yr
c) Advanced Volume Reduction 2/	5,000 ft^3/yr
Low Level Waste, Generated Offsite	
a) Uranium Mill, Tailings Solutions 3/	254,000 MT/yr
Tailings Solids 3/	96,000 MT/yr
b) UF_3 Conversion	1,200 ft^3/yr
c) Enrichment 3/, 4/	50 ft^3/yr
d) Fuel Fabrication	750 ft^3/yr
Transuranic Waste, Generated Onsite and Offsite	0

1/ Roughly 40% of current volumes generated is contaminated trash.

2/ This estimate reflects the use of methods which are presently not economical. Current, allowable activity levels per package may preclude actual achievement of this level in the future.

3/ These wastes are currently disposed of at the processing facility site.

4/ This value is based on gaseous diffusion technology. The new centrifuge process could potentially generate more (up to 2900 ft^3/yr).

TABLE 3

REPOSITORY DESIGN ASSUMPTIONS

(Commercial and DOE)

		CASE 1	CASE 2
A.	HLW, thermal emplacement density	150 KW/acre 1/	100 KW/acre 2/
B.	Spent fuel, mass emplacement density	50 metric tons/acre	33 metric tons/acre 2/
C.	TRU and other non-heat limited waste	36,500 ft^3/acre	Same as Case 1

1/ The areal requirements are strongly dependent on the emplacement densities employed. It should be noted, however, that a basis for choosing a thermal emplacement density has not been established. The integrated thermal output of spent fuel is appreciably higher than that of high level reprocessing waste due to the large quantity of contained transurancis. In addition, the integrated thermal output of spent fuel in the repository is fairly insensitive to the age of the fuel at the time of emplacement. Therefore, the meaningful measure of spent fuel emplacement density with respect to concerns about far field effects of temperature would be tons/acre not thermal emplacement density. Model calculations have shown that spent fuel emplaced at 50 metric tons/acre produces similar far field effects as 10 year high level reprocessing waste emplaced at 150 KW/acre. If the spent fuel is 10 years old at the time of emplacement, its thermal output is 1.2 KW/metric ton. In addition, the thermal emplacement density for high level reprocessing waste or the mass emplacement density for spent fuel will be very site dependent and the emplacement densities could well differ by as much as a factor of two among the two wastes and among different repository sites.

2/ Arbitrarily established at 2/3 of the Case 1 values to reflect technical conservatism.

TABLE 4 - TOTAL COMMERCIAL LLW GENERATED - CASE 1
(Millions of cubic feet)

Year	Reactors and Fuel Cycle 1/	Non-Fuel Cycle	D&D 2/	Total Ann.	Total Cum.	Burial Ground Acres Required 3/
1980	2.87	1.0	0	3.87	14.26	51.85
1985	2.15	1.5	0	3.65	29.97	108.98
1990	1.03	2.0	0	3.03	45.03	163.75
1995	1.03	2.5	0	3.53	62.68	227.93
2000	1.03	3.0	0.01	4.04	82.84	301.24

1/ Reflects present experience (77-80), design basis (81-5), and advanced volume reduction (86-2000) for reactor wastes.

2/ Mothball 5 reactors, each yielding 2000 ft^3.

3/ At 275,000 ft^3/acre.

TABLE 5 - TOTAL COMMERCIAL LLW GENERATED - CASE 2
(Millions of cubic feet)

Year	Reactors and Fuel Cycle 1/	Non-Fuel Cycle	D&D 2/	Total Ann.	Total Cum.	Burial Ground Acres Required 3/
1980	2.87	1.0	0	3.87	14.26	51.85
1985	5.98	1.5	0	7.48	44.40	161.45
1990	9.14	2.0	0	11.14	93.60	340.36
1995	13.28	2.5	0.1	15.88	164.24	597.24
2000	17.84	3.0	0.1	20.94	260.00	945.45

1/ Based on current experience, no volume reduction.

2/ Dismantle 5 reactors.

3/ At 275,000 ft^3/acre.

Both tables also provide the acres of burial ground required to accommodate these wastes assuming an average utilization factor based on commercial practice of 275,000 ft^3/acre. As shown, the cumulative acres required differ by a factor of about 1.5 in 1985, 2 in 1990, and 3 in the Year 2000. The 1985 difference is due solely to lower unit quantities generated by reactors, such nuclear capacity in 1985 for both cases is the same, whereas the difference in the year 2000 is due about equally to differing nuclear capacity levels and unit quantities deriving from volume reduction techniques.

Projections of LLW resulting from DOE programs are given for Case 1 and 2 assumptions in Table 6 and 7 respectively. Case 1 results depict a constant generation rate of 1.25 million ft^3/year from normal operations through 1985, when volume reduction techniques which cut the rate to 1/5 the original level are assumed. This assumption is generally consistent with current DOE R&D programs for developing volume reduction technology. Case 2 projects the constant rate of 1.25 million ft^3/year through 2000.

The D&D program impacts reflect "small" and "moderate" programs for Cases 1 and 2 respectively. The "other" category pertains only to Case 1 and includes about 10 million cubic feet of decontaminated salt recovered from the removal of radionuclides from HLW present at RL and SR. For calculational purposes, the projected HLW inventory for the beginning of 1985 is assumed to be processed over the preceding five years with the follow-on rate representing the decontaminated salt cake derived from newly generated HLW after 1984. (This may not reflect actual, future practice).

Also shown is the burial ground acreage required, assuming the commercial practice rate of 275,000 ft^3/acre. Though DOE experience to date is actually about 1/2 this value, it is assumed that the assumption of responsibilities for commercial burial grounds, as proposed under the new policy, will lead to licensing of all sites. This coupled with the premium placed on dedicating land for this purpose in the future, may result in a future DOE utilization factor more comparable to commercial experience.

The acreage of burial grounds required to handle LLW from DOE and commercial sources are summarized in Table 8 for both cases. The commercial results show that additional acreage beyond the presently unused and licensed 360 acres would be required after 2000 for Case 1 and around 1990 for Case 2.

TABLE 6 - TOTAL DOE LLW GENERATED - CASE 1
(Millions of cubic feet)

Year	Base	D&D	Other	Total Ann.	Total Cum.	Burial Ground Acres Required 2/
1980	1.25	0	2.03 1/	3.28	7.03	25.56
1985	1.25	0.5	0.16	1.91	24.06	87.49
1990	1.25	0.5	0.16	0.91	28.61	104.04
1995	0.25	0.5	0.16	0.91	33.16	120.58
2000	0.25	0.5	0.16	0.91	37.71	137.13

1/ Decontaminated salt from SR & RL HLW processing. Backlog is assumed to be worked off by beginning of 1985, though this may not be the actual practice.

2/ At 275,000 ft^3/acre. Actual experience has been roughly half this value in the past.

TABLE 7 - TOTAL DOE LLW GENERATED - CASE 2
(Millions of cubic feet)

Year	Base	D&D	Other	Total Ann.	Total Cum.	Burial Ground Acres Required 1/
1980	1.25	0	0	1.25	5.0	18.18
1985	1.25	8.0	0	9.25	51.25	186.36
1990	1.25	8.0	0	9.25	47.50	354.55
1995	1.25	8.0	0	9.25	143.75	522.73
2000	1.25	8.0	0	9.25	190.00	690.91

1/ At 275,000 ft^3/acre. Actual experience has been roughly half this value in the past.

TABLE 8 - LLW GROUND REQUIRED
(acres[1/])

By Year	Case 1 DOE	Case 1 Commercial	Case 1 Total	Case 2 DOE	Case 2 Commercial	Case 2 Total
1990	26	52	78	18	52	70
1985	87	109	196	186	161	347
1990	104	164	268	355	340	695
1995	121	228	349	523	597	1120
2000	137	301	438	691	945	1636

1/ Assuming average utilization of 275,000 ft^3/acre. Excludes acreage used through January 1, 1977.

Present LLW Situation

There are six licensed, commercial low level burial ground currently existing in the United States, but two are presently closed. Waste buried to date at these sites is summarized in Table 9 and totals 15.8 million cubic feet.

The current volume of DOE low level waste buried at seven major sites and numerous smaller ones is shown in Table 10 and equals almost 51 million cubic feet, consisting of 7,000,000 cubic feet of dried sludge and 44,000,000 cubic feet of solids, These quantities include DOE transuranic waste buried prior to 1975.

IV. TRANSURANIC WASTES (TRU)

For case purposes, all TRU wastes are assumed to be emplaced in DOE geolgoic repositories, including commercial TRU. Transuranic waste is defined as low level waste with concentrations of transuranic elements in excess of 10 nanocuries/gram. This value is under review by NRC and DOE and may well increase upward. If this happens, the TRU waste volumes would decrease. The reclassified waste would be low level and suitable for shallow land burial.

TABLE 9

EXISTING COMMERCIAL LOW LEVEL WASTE (LLW)
(as of 1/1/77)

Site	Status	Millions of Cubic Feet Buried 1/
Barnwell, S.C.	Open	3.52
Beatty, Nev.	Open	1.97
Hanford, Wash.	Open	0.51
Maxey Flats, Ky.	Closed	4.95
Sheffield, Ill.	Open	2.40
West Valley, N.Y.	Closed	2.46
	Total	15.81

1/ Includes commercial TRU waste buried.

Projected quantities of TRU waste generated by DOE programs and commercial sources* are given in Tables 11 and 12 for Cases 1 and 2, respectively. For DOE programs, a constant generation rate of 250,000 ft^3/yr is assumed for Case 2 whereas Case 1 reflects a volume reduction to 1/5 the original level, as assumed earlier for LLW. However, since stored and newly generated TRU will be readily available prior to emplacement in a repository, volume reduction is assumed to apply to both. TRU wastes resulting from the small and moderate DOE D&D programs used in the earlier LLW section also apply. Commercial generation rates in both cases are assumed to continue at their 1977 levels (10,000 ft^3/yr). Case 2 also assumes exhumation of all previously buried DOE TRU waste over the 1981-90 timeframe. Volume reduction of wastes from commercial sources, exhumation, and D&D is not assumed.

The acres of repository required to receive these quantities are also shown. An effective utilization factor of 36,000 ft^3/total acre is used since TRU wastes are not heat limited. As shown, the acreage requirements by the year 2000 differ by a factor of over 15. The predominant reason for this difference is the much larger scope of the D&D program assumed for DOE under Case 2. All TRU wastes are assumed to be shipped to a geologic repository for disposal.

Present TRU Situation

Existing inventories of commercial transuranic waste are buried at five of the six commercial low level burial sites (i.e., the Barnwell, South Carolina, site has always prohibited burial of transuranic wastes). The transuranic content of low level waste buried totals 123 kilograms, and ranges from 69 kilograms at Maxey Flats, Kentucky, to 4 kilograms at West Valley, New York, as shown in Table 13. The only commercial waste burial site currently receiving TRU waste is Hanford.

* It is assumed that spent fuel is not reprocessed.

Table 10

EXISTING DOE LOW LEVEL WASTE (LLW)
(as of 1/1/77)

Site	Millions of Cubic Feet Buried 1/
Hanford, Wash.	6.40
Idaho Falls, Idaho	5.27
Los Alamos, N.M.	8.55
Oak Ridge National Lab., Tenn.	6.42
Savannah River, S.C.	9.27
Nevada Test Site	0.27
Sandia Lab., N.M.	0.04
Other 2/	14.59
Total	50.81

1/ Includes previously buried TRU waste.

2/ These are wastes contaminated with uranium only which are buried onsite at Pantex (Texas), FMPC (Ohio), National Lead (N.Y.). ORGDP and Y-12 (Tenn.). Paducah (Ky.), Portsmouth (Ohio), and Weldon Springs (Mo.).

TABLE 11 - TOTAL TRU WASTE GENERATED - CASE 1
(millions of cubic feet)

Year	DOE Base	DOE D&D	Commercial 1/	Total Ann.	Total Cum.	Repository Acres Required 2/
1980	0.05	0	0.01	0.06	0.58	15.9
1985	0.05	0.25	0.01	0.31	2.13	58.4
1990	0.05	0.25	0.01	0.31	3.68	100.8
1995	0.05	0.25	0.01	0.31	5.23	143.3
2000	0.05	0.25	0.01	0.31	6.78	185.8

1/ Assumes cessation of burial of commercial TRU.
2/ At 36,000 ft^3/acre.

TABLE 12 - TOTAL TRU WASTE GENERATED - CASE 2
(millions of cubic feet)

Year	DOE Base	DOE D&D	DOE Exhumation	Commercial	Total Ann	Total Cum.	Repository Acres Required 1/
1980	0.25	0	0	0.01	0.26	2.76	75.6
1985	0.25	4.75	1.3	0.01	6.31	34.31	940.0
1990	0.25	4.75	1.3	0.01	6.31	65.86	1804.4
1995	0.25	4.75	0	0.01	5.01	90.91	2490.7
2000	0.25	4.75	0	0.01	5.01	115.96	3177.0

1/ At 36,000 $ft.^3$/acre.

Table 13

EXISTING COMMERCIAL TRANSURANIC (TRU) WASTE
(as of 1/1/77)

SITE	BURIED TRANSURANIC QUANTITIES (KG)1/
Barnwell, SC	0
Beatty, NV	14.3
Hanford, WA	22.7
Maxey Flats, KY	69.1
Sheffield, IL	13.4
West Valley, NY	3.6
	123.1

1/ The associated volumes of TRU waste are not known. The only site presently receiving commercial TRU waste for burial is Hanford.

Table 14

EXISTING DOE TRU WASTE
(millions of cubic feet as of 1/1/77)

	Buried[1/]	Retrievably[2/] Stored	Total
Hanford, WA	5.40	0.27	5.67
Idaho Falls, ID	2.30	1.28	3.58
Los Alamos, NM	4.10	0.06	4.16
ORNL, TN	0.20	0.05	0.25
Savannah River, SC	1.00	0.06	1.06
Nevada Test Site	< 0.01	< 0.01	< 0.01
Total	13.00	1.72	14.72
Transuranic Content (KG)	(>700)	(374)	(>1100)

[1/] These are approximate volumes of TRU waste included in the buried LLW. Burial of DOE TRU waste ceased in 1974 (most sites in 1970).

[2/] Do not reflect any potential volume reduction.

Approximately 15,000,000 cubic feet of TRU waste exist at six DOE sites, as shown in Table 14. Of that total volume, nearly 2,000,000 cubic feet is retrievably stored while the balance is buried. Burial of DOE TRU waste ceased at most sites in 1970 and at all sites by 1974.

Intermediate Level Waste - Oak Ridge

Some radioactive wastes generated at the Oak Ridge National Laboratory are disposed of onsite by mixing the wastes with cement and injecting the resultant grout into the shale medium (after hydrofracturing) which exists below the site. This technique has resulted in the disposal of 1,600,000 gallons as of January 1, 1977. Of that total, approximately 25 percent consisted of sludge and the remainder, waste solution. Annual additions of approximately 90,000 gallons are expected to continue for the foreseeable future. This disposal technique has no effect on burial grounds or repository requirements.

V. HIGH LEVEL WASTES (HLW)

High level waste resulting from DOE defense and R&D related programs exists in a variety of forms at a number of sites. Total volumes of high level waste stored at the Savannah River, Idaho and Hanford sites currently equals 9.4 million cubic feet and is projected to decline to 9.1 million cubic feet in 1985 as a result of evaporation and processing (cesium/strontium recovery and encapsulation; calcining of HLW). Liquids constitute about 40 percent of the current volume, with salt cake and sludge representing nearly all of the remainder.

High level wastes have also accumulated through the operation of the only commercial reprocessing plant in the United States, the NFS facility at West Valley, New York (which is shutdown). These wastes currently total 82,000 cubic feet and are stored in the form of liquids in underground tanks.

It is assumed below that all existing HLW (Table 15) and material projected through 1984 (Table 16) are converted into whatever final form is chosen for each case by the end of 1984. This may not reflect actual practice in the future. HLW generated after 1984 is assumed to be processed immediately.

Table 15

EXISTING HIGH LEVEL WASTE (HLW)[1/]
(Thousands of cubic feet as of 10/1/77)

DOE	Total	Liquid	Salt Cake	Sludge	Calcine	Cs;Sr Capsules
Savannah River	2900	1700	900	300	0	0
Idaho	404	350	0	0	54	0
Hanford	6102.5	1600	2800	1700	0	2.5
Sub	9406.5	3650	3700	2000	54	2.5
West Valley (NFS)[2/]						
Neutralized (600,000 gal.)	80.2	80.2	0	0	0	0
Acidic (12,000 gal.)	1.6	1.6	0	0	0	0
Sub	81.8	81.8	0	0	0	0
Total	9488.3	3731.8	3700	2000	54	2.5

1/ This reflects the present form of the existing waste, not necessarily the form that would be placed in permanent disposal.

2/ The neutralized waste is stored in a 750,000 gal. carbon steel tank while the acidic waste is in a 15,000 gal. stainless steel tank. There is a spare tank for each in case of leaks.

TABLE 16

PROJECTED HLW (as of 1/1/85)
(Thousands of cubic feet)

DOE	Total	Liquid	Salt Cake	Sludge	Calcine	Cs;Sr Capsules
Savannah River	2630	560	1660	410	0	0
Idaho	310	150	0	0	160	0
Hanford[1/]	6122.9	1340	3060	1720	0	2.9
Sub	9062.9	2050	4720	2130	160	2.9
West Valley (NFS)						
Neutralized	80.2	80.2	0	0	0	0
Acidic	1.6	1.6	0	0	0	0
Sub	81.8	81.8	0	0	0	0
Total	9144.7	2131.8	4720	2130	160	2.9

[1/] This assumes that the entire backlog of fuel from N reactor has been processed by 1/1/85 (i.e., Purex startup), which may not necessarily be the case.

VI. REPOSITORY REQUIREMENTS FOR TRU AND HLW

The acres of repository required for TRU and HLW Cases 1 and 2 are summarized in Table 17. The requirements are principally driven by the TRU waste quantities.

TABLE 17 - CUM. REPOSITORY ACRES REQUIRED (DOE AND WEST VALLEY) 1/

	Case 1			Case 2		
	TRU	HLW	TOTAL	TRU	HLW	TOTAL
1985	58.4	43.2	101.6	940.0	377.9	1317.9
1990	100.8	46.9	147.7	1804.4	415.6	2219.0
1995	143.3	50.7	194.0	2490.7	453.4	2955.1
2000	185.8	54.4	240.2	3177.0	491.1	3668.1

While there is no compelling land-use reason to pursue volume reduction of TRU, such techniques might be necessary for repository safety reasons such as prevention of placement of combustible material (fire hazard) or of waste that might generate significant quantities of gas through decomposition.

VII. REPOSITORY REQUIREMENTS FOR COMMERCIAL SPENT FUEL

For a once-through fuel cycle, spent fuel is assumed to be disposed of in geologic repositories. General repository design assumptions and maximum loading rates are presented in Table 18 for two cases. The lower assumed mass emplacement density* for the spent fuel in Case 2 results in a 2000 acre repository capacity of two-thirds the capacity under Case 1 assumptions. Since the ability to handle canisters containing spent fuel is the limiting factor, maximum loading rates are the same in both cases. Repository and away-from-reactor (AFR) storage requirements for both cases were calculated, assuming the first repository is available in 1988 (first full year 1989). For this analysis, an AFR is assumed to hold 5,000 MT of spent fuel.

1/ These schedules are not to imply that the material must be emplaced in the time frame shown. Rather, the results define the acreage requirements as a function of time *if* the material and repository(s) were both available.

* Case 2 mass emplacement density was arbitrarily set at two-thirds of the value used in Case 1 to reflect technical conservatism repository design.

TABLE 18 - COMMERCIAL REPOSITORY DESIGN DATA

Assumptions: 1) 2000 acre repository

2) Spent fuel cooled 5 (or more) years

3) Loading rates (maximum)

Year	MT
Partial Year	100
First Full Year	1,500
2	5,000
3	5,000
4	5,000
5 on, until full	10,000

4) Earliest time of full loading

Case 1 - 13 years

Case 2 - 9 years

For Case 1, Table 19 shows that only one repository is needed through 2005 and probably wouldn't be full for another 2 1/2 years. The maximum Government AFR requirement of 11,800 MT of storage occurs in 1989 and is worked off in five years.

AFR requirements are expected to reach a maximum level during operation of the first repository and then decline as the backlog is worked off. In order to obtain conservative estimates of repository needs, the AFR backlogs are assumed to be depleted as rapidly as possible. Once the AFR's have been emptied, the schedule for subsequent repositories is determined by not allowing another buildup in AFR spent fuel inventory. In effect, the AFR's can be considered as standby capacity in the event repositories are delayed, or in the extreme, if a repository must be emptied early in its operational life due to some unforeseen occurrence.

TABLE 19 REPOSITORY AND AFR REQUIREMENTS - CASE 1 1/
(in MT of Heavy Metal)

YEAR	CUMULATIVE SPENT FUEL AVAILABLE	CUMULATIVE LOADING REPOSITORY #1	GOVERNMENT AFR STORAGE REQUIRED
82	0		0
3	1300		1300
4	3000	0	3000
5	4600	0	4600
6	6400	0	6400
7	8400	0	8400
8	10,700	100 (Startup)	10,600
9	13,400	1600	11,800 (Max.)
90	16,600	6600	10,000
1	20,100	11,600	8500
2	24,200	16,600	7600
3	28,500	26,600	1900
4	33,000	↑	0
5	37,700	Same as Spent Fuel Available (Loading Limited By Demand)	↓
:	:	↓	↓
2003	78,000	↓	↓
2004	83,300	↓	↓
2005	88,600	↓	↓

1/ Spent fuel is cooled a minimum of 5 years prior to "availability". The cumulative quantity of spent fuel available has been reduced by the amount available through 1982 (4200 MT) to reflect a like amount of material being kept in onsite storage pools and any required private AFR capacity.

If the first repository were delayed, the amount of Government AFR storage required and the time necessary to work off the backlog would increase (Table 20). The AFR requirement roughly doubles for a 3-year delay and triples for a delay of 5 years in the first repository. Due to assumed AFR loading and unloading limitations of 1500 MT/yr, more AFR's would be required for delays of 1 or 2 years than implied by storage requirements.

In Case 2, higher nuclear growth assumptions and the lower capacity of a repository will lead to a greater number of repositories required. As shown in Table 21, two repositories are needed through 2005. The second repository will need to start up in 1997, with a third and fourth required shortly after 2005. The third and fourth repositories are necessary since the first two will be full by then and the rate of increase in spent fuel availability (about 10,000 MT/yr) is roughly double the permitted loading rates during the second through fourth years of operation (5000 MT/yr). Once full design loading is possible, the latter two repositories should be sufficient for a number of years until the spent fuel availability rate increases markedly or the repositories are filled.

The impact of delays in the first repository on Case 2 results is shown in Table 22. In the case of delays of 3-5 years, the second repository is needed in 1996 (1 year earlier).

A variation of Case 2 was calculated using the mass emplacement density (50 metric tons/acre) assumption of Case 1. The AFR requirements, delay impacts, and times required to eliminate the spent fuel inventory for the base case and various delays analyzed were the same as in Case 1 for delays up to 3 years, since spent fuel availability from reactors in excess of 148 GWe does not occur until 1999. The need for a second repository, however, was advanced to 2001 (from 2007-8 in Case 1).

Spent Fuel Discharges

Annual and cummulative quantities of U.S. spent fuel discharged are shown in Table 22 for projected nuclear capacity of 148 and 380 GWe by the year 2000. Spent fuel is presently stored in water storage pools on the reactor site and storage facilities in Morris, Illinois and West Valley, New York. Also shown is 10% of the foreign, free-world discharges projected through the year 2000.

TABLE 20 GOVERNMENT AFR NEEDS FOR DELAYS IN FIRST REPOSITORY - CASE 1

Years of Delay	Maximum Government AFR Storage (MT)	Year of Max. AFR	Minimum Time Required To Eliminate Backlog (Years)	Number of AFR's 1/
0	11,800	1989-90	5	3
1	15,000	1990-1	5	4
2	18,500	1991-4	7*	4
3	22,600	1992-5	8*	5
4	26,900	1993-6	9*	6
5	31,400	1994-7	10*	7

* The backlog remains relatively constant for four years and then declines.

1/ An AFR facility could have a storage capacity of 3-10,000 MT, with a typical value of 5,000 MT used above.

TABLE 21 REPOSITORY AND AFR REQUIREMENTS - CASE 2[1]
(in MT of Heavy Metal)

YEAR	CUMULATIVE SPENT FUEL AVAILABLE	CUMULATIVE LOADING REP #1 (1988 startup)	CUMULATIVE LOADING REP #2	GOVERNMENT AFR STORAGE REQUIRED
(Same results as Case 1 through 1993)				
1993	28,500	26,600	0	1900
4	33,200	33,200*	↓	0
5	38,000	38,000*	↓	↓
6	43,900	43,900*	↓	↓
7	49,900	49,800[2]	100 (startup)	↓
8	56,300	54,700[2]	1600	↓
9	63,200	56,600[2]	6600	↓
2000	70,600	59,000[2]	11,600	↓
01	78,500	61,900[2]	16,600	↓
02	87,000	64,000*	23,000*	↓
03	95,900	66,000	29,900*	↓
04	105,400	↓	39,400*	↓
05	115,300	↓	49,300*	↓

*Determined by demand, not loading rate.

1/ Same assumptions on spent fuel availability as Case 1.

2/ Loading is reduced in Repository #1 in order to gain experience in bringing Repository #2 up to early design loading rates.

TABLE 22

SPENT FUEL GENERATED[1/]
(MT of Heavy Metal)

	DOMESTIC					
	148 GWe		380 Gwe		10% of Foreign	
YEAR	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE
Existing	-	2,300	-	2,300	-	600[2/]
1977	1,000	3,300	1,000	3,300	300	900
1978	1,100	4,400	1,100	4,400	200	1,100
1979	1,300	5,700	1,300	5,700	400	1,500
1980	1,300	7,000	1,300	7,000	300	1,800
1981	1,400	8,400	1,400	8,400	400	2,200
1982	1,600	10,000	1,600	10,000	400	2,600
1983	1,900	11,900	1,900	11,900	400	3,000
1984	2,200	14,100	2,200	14,100	500	3,500
1985	2,700	16,800	2,700	16,800	500	4,000
1986	2,900	19,700	2,900	19,700	600	4,600
1987	3,400	23,100	3,400	23,100	700	5,300
1988	3,600	26,700	3,600	26,700	700	6,000
1989	3,700	30,400	3,900	30,600	800	6,800
1990	3,700	34,100	4,200	34,800	1,000	7,800
1991	3,800	37,900	4,600	39,400	900	8,700
1992	3,800	41,700	4,900	44,300	1,100	9,800
1993	3,800	45,500	5,200	49,500	1,200	11,000
1994	3,800	49,300	5,700	55,200	1,200	12,200
1995	3,700	53,000	6,000	61,200	1,400	13,600
1996	3,700	56,700	6,500	67,700	1,400	15,000
1997	3,700	60,400	6,900	74,600	1,600	16,600
1998	3,600	64,000	7,300	81,900	1,600	18,200
1999	3,600	67,600	7,800	89,700	1,700	19,900
2000	3,500	71,100	8,100	97,800	1,800	21,700

1/ Volume is about 13.1 ft^3 /MT HM for spent fuel.
2/ Excludes discharges prior to 1975.

VIII. TRANSPORTATION REQUIREMENTS FOR SPENT FUEL, HLW, AND TRU

Shipments of spent fuel from industry to the Government and the corresponding requirements for shipping casks are given in Table 23 for both cases. There are 9 truck casks and 4 rail casks available for use today.

Truck and rail casks also will be required to unload spent fuel from Government AFR's and ship it to repositores. Assuming Government AFR's are unloaded as rapidly as possible and accounting for possible delays in repository opening, the transportation requirements would be as shown in Table 24.

Finally, the movement of HLW from DOE sites and West Valley, N.Y. will place demands on the same transportation resources. For Case 1, HLW will require 1,590 shipments/year (21 truck casks, and 57 rail casks) on the average, for each year from 1985 to 2000. Over the same period, Case 2 will require 2,530 shipments/year (33 truck casks, and 91 rail casks). Both of these results are comparable to the industry spent fuel shipments required under each case.

Taken together, these requirements sum to roughly 200-270 casks needed in the 19990's (5000-6500 shipments per year). These requirements more than triple the transportation requirements for the 1990's when compared to industry needs alone.

The magnitude of the total transportation requirement raises serious doubts as to the feasibility of meeting these needs and, thus, questions the wisdom of emptying AFR's as rapidly as possible. The problem is overstated since AFR's will probably remain full for longer periods and HLW disposal will probably occur over a period greater than the 15 years assumed.

Transportation Requirements for TRU

In the U.S., DOE TRU is currently being shipped in AMTX rail cars. There are now 10 AMTX units in service, each capable of averaging 14 shipments/year while carrying 1000 ft^3 of TRU/shipment.

Assuming that the TRU generated in Case 1 (6.78 million ft^3) is moved over 15 years, this would require 33 AMTX rail cars averaging about 452 shipments/year starting in 1986. Using similar assumptions for Case 2, its 116.0 million ft^3 of TRU would require about 553 AMTX railcars making about 7731 shipments/year.

TABLE 23 - DOMESTIC SPENT FUEL TRANSPORTATION[1/]
(from industry to Government)

Assumptions:
1) Shipments 90% rail, 10% truck
2) Casks in service 275 days/year
3) Cask capacities: 4.5 MT rail; 0.5 MT truck
4) Average round trip: 20 days rail; 7 days truck
5) Cask capability per year:
   rail @ 14 shipments/yr = 63.0 MT/yr per cask
   truck @ 39 shipments/yr = 19.5 MT/yr per cask

	Case 1					Case 2				
	Annual	Shipments		Casks		Annual	Shipments		Casks	
Year	Spent Fuel (MT)	Truck	Rail	Truck	Rail	Spent Fuel (MT)	Truck	Rail	Truck	Rail
1985	1300	260	260	7	19	1300	260	260	7	19
1990	2700	540	540	14	39	2700	540	540	14	39
1995	3700	740	740	19	53	4200	840	840	22	60
2000	3700	740	740	19	53	6000	1200	1200	31	86
2005	3700	700	700	18	50	8100	1620	1620	42	116

[1/] This does not include (1) any shipments from a Government AFR to a repository, (2) foreign shipments, or (3) HLW shipments.

TABLE 24 - TRANSPORTATION REQUIREMENTS TO UNLOAD AFR'S

	Delay (Yrs.) in First Repository					
	0	1	2	3	4	5
Case 1						
Total # of Shipments	4720	6000	7400	9040	10760	12,560
Time of Peak Withdrawal[1/]	1993	1995	1995-6	1998	1998	1998
Shipments in Peak Year	2280	2560	2120	2040	2040	2040
Additional Casks Required in Peak Year	60	66	56	54	54	54
Case 2						
Total # of Shipments	4720	6000	7400	9040	10,920	13.320
Time of Peak Withdrawal[1/]	1993	1994	1995	1996	1997	1998
Shipments in Peak Year	2280	2120	2080	1640	1600	1440
Additional Casks Required in Peak Year	60	56	54	44	42	38

[1/] This assumes that Government AFR's are emptied as rapidly as possible. The same split for rail and truck traffic is assumed as in Table K-29.

IX. Costs

The estimated costs associated with the implementation of the waste management program are listed in Table 26.

Table 26 - COST ESTIMATES THROUGH 2000

(billions of undiscounted, constant 1977 dollars)

	Case 1	Case 2
Facilities and Programs (excl. R&D)		
Commercial and DOE Repositories	3.0 - 3.8	5.6 - 7.3
Away-From-Reactor-Storage - AFR's	0.7 - 0.9	0.7 - 0.9
LLW/TRU Operations	0.6 - 0.9	1.8 - 2.4
HLW Treatment Programs	4.2 - 5.2	3.5 - 4.4
DOE Transportation	1.0 - 1.2	1.9 - 2.1
Sub total	9.5 - 12.0	1.9 - 17.1
DOE R&D Programs	1.5 - 1.7	1.5 - 1.7
Contingency	2.0 - 3.0	3.0 - 4.0
Total costs through 2000	13 - 17	18 - 23

APPENDIX E

SUMMARY OF PROPOSED EPA ENVIRONMENTAL PROTECTION CRITERIA FOR RADIOACTIVE WASTE

THE PROPOSED EPA ENVIRONMENTAL PROTECTION CRITERIA FOR RADIOACTIVE WASTES WERE PUBLISHED BY EPA IN THE FEDERAL REGISTER OF NOVEMBER 15, 1978, PART IX.

Appendix F

Risks Due to the Disposal of High Level Radioactive Waste

I. Introduction

This appendix discusses the problem of isolating high level radioactive wastes from the biosphere, the risk due to the wastes, and the current status of risk assessments. Extended discussion may be found in Appendix A of the Subgroup One report on Alternative Technology Strategies.

Basic Principles and Concepts

The intense radioactivity and persistence over several hundreds to hundreds of thousands of years of radionuclides contained in high level wastes make it imperative that these be isolated from the biosphere until they have decayed to safe levels of activity. Emplacement in a conventionally mined geologic repository is the most readily implemented means of effecting such isolation. Once such a repository is filled with radioactive waste and sealed, radionuclides contained in the waste can be returned to the biosphere in only two credible ways: (1) by exposure of the rock mass that contains the radionuclides, either through exhumation or through physical movement of this mass to the surface; or (2) by dissolution of the waste by ground water and movement of the radionuclides with the ground water to a river, lake, well, or other point of discharge at the surface. Either natural processes or human activities could conceivably lead to exposure of the buried waste, but analysis indicates that if appropriate site criteria are applied, the probability of this occuring would be negligible. Thus, the most likely mechanism of transfer is through dissolution and transport by ground water.

The task of accurately predicting over periods of several hundreds to hundreds of thousands of years the fate of deeply buried radionuclides is, to say the least, unprecedented and challenging. The problem involves three important aspects: first, the amount and rate of supply of radionuclides to the ground water; second, the pathways and rate of groundwater movement; and third, the degree of retardation of radionuclide movement caused by chemical interactions with the porous media through which the ground water moves. All three aspects influence, and any one of the three conceivably could independently control, the potential hazard imposed by radionuclide migration from a geologic repository.

The risks associated with the disposal and long-term isolation of radioactive wastes cannot be verified or disproved on the basis of operating experience, experimentation, or prototype testing (mathematical modeling). Rather, the risks to public health and the quality of the environment must be assessed through a complicated chain of inference and hypothesis. Such a situation is not unique to the assessment of risks due to radioactive wastes, but is common to the assessment of risk due to many materials hazardous to human health and the environment (e.g., arsenic, pesticides, carbon dioxide, fluorocarbons, etc.).

The assessment of risk basically consists of three types of activities--failure mode analysis, probability estimation, and consequence assessment. Failure mode analysis involves the identification of potential release initiating events and sequences of events and processes (scenarios) that lead to the release of radioactive material to the biosphere. Failure mode analysis is based largely on a combination of scientific reasoning, engineering experience, and intuition; there is no method to assure that such analysis identifies all potential events of significance. However, with time it is possible to increase our confidence that the dominant contributors to risk have been identified. The second step in risk assessment involves an estimation of probabilities associated with the scenarios identified in the failure mode analysis. This final step in risk assessment is the determination of the consequences of the potential releases of radioactive materials as identified in the failure mode analysis. The consequences are typically quantified in terms of radiation doses or human health effects.

Approaches to Management of Wastes

There are two basic approaches to management of any waste: dilute and disperse, or capture and isolate. Historically, the dispersion approach has been used for many wastes (including some radioactive wastes or effluents) with the expectation that dilution and natural phenomena would be sufficient to maintain public health and environmental risks at acceptable levels. It has long been recognized, however, that dispersion would not be an acceptable approach to management of most radioactive wastes from defense related programs and commercial nuclear power. Management of these wastes is therefore based on isolation. If the wastes can be successfully isolated for time periods sufficient for the radioactivity to decay to low levels, risks can be avoided or maintained at negligible levels.

Principles of Waste Isolation

To help assure effective isolation of radioactive wastes from the biosphere, reliance is placed on the multiple barrier concept. In this concept, the principal barrier is a sufficiently long "travel time" for radionuclides to be transported by ground water. Additional barriers are provided by engineered features such as the waste form itself, the canister and over-packing material, and natural features which contribute to chemical retardation of radionuclides that might be dissolved in the ground water. Not all barriers are mutually independent. Clearly, for the multiple barrier concept to be valid, each barrier must either stand independently or its effectiveness must be evaluated in consideration of possible changes in other barriers.

In addition to reliance on multiple barriers for isolation of radioactive waste, the repository itself will be sited and designed to minimize both the likelihood of disruptive events affecting it and the consequences of such disruptive events. The proper siting of the repository is achieved by utilizing adequate site selection criteria. The repository can be designed to minimize the effects of the repository on its geologic and hydrogeologic environment.

II. Risk Estimation Methods

As previously noted, risk estimation requires three separate activities. These are briefly address below.

Failure Mode Analysis

It is expected that only areas with a history of geologic stability will be considered as potential candidates for waste repositories. Past stability would appear to be a reasonable requirement for repository site selection. However, a history of geologic stability is not sufficient to assure future stability for the area, with or without the development of a repository. The development of a waste repository could contribute to a significant alteration of the local stress field, and no amount of backfilling or sealing of shafts will restore the area completely to its original conditions. Once a repository is filled and sealed, the area containing it might evolve differently than if the repository had not been placed there. Potential failure modes therefore are of two types, those that are self induced and those that occur independently of the presence of the repository.

Failure mode analysis attempts to identify mechanisms by which radionuclides could leave a repository, travel through surrounding formations, and enter the biosphere. The most important aspect of failure mode analysis is the development of plausible scenarios by which the repository system, with its multiple barriers, allows the release and transport of radionuclides from stored wastes. The end result is a time dependent estimate of the quantity o radionuclides reaching the biosphere.

Much of the risk assessment work to date has dealt with failure mode analysis. In general, potentially adverse influences on repository stability are grouped into sets associated with:

- Sudden disruptive events and processes (e.g., meteorite impact, earthquakes, vulcanism).
- Slow disruptive events and processes (e.g., dissolution by ground water, rock deformation, regional uplift and erosion, glaciation).
- Engineering related problems (e.g., shaft seal failures, thermal stresses, chemical effects).
- Human-caused events independent of the repository (e.g., inadvertent drilling, dams, surface explosions).
- Undetected features (e.g., shear zones, mineral resources, boreholes and cavities).

Although the identification of dominant mechnisms of release should be a primary goal, the results of published risk assessements are inconsistent in this regard. This inconsistency largely reflects our lack of detailed knowledge of the system and how it might behave in the future. More detailed risk assessments, now in progress, might lead to consistency in identifying dominant mechanisms, and possibly to event sequences that contribute most substantially to those mechanisms.

Probability Estimation

An important limitation in the ability to assess risk lies in assigning probabilities to geological processes and events both for the long term and for immediate engineering interest. Development of probabilistic models in the earth sciences is recent, but advancement of the techniques is proceeding rapidly. The difficulties of modeling geologic and hydrologic processes is a serious limitation to risk assessment. It is possible that "conditional" risks might have to be calculated -- i.e., risks that would exist if the assumptions made in the analysis about future events (climatic factors, land use, etc.) hold. This approach has precedent in other areas of nuclear safety and policy analysis for public risk.

Consequence Assessment

If radionuclides are released from the point of emplacement of waste, they must move through surrounding geologic strata before entering the biosphere. This movement will be substantially controlled by the hydrogeologic regime, inasmuch as ground water provides the means for movement of dissolved radionuclides. The flow field and potential pathways for dissolved waste to reach the biosphere are difficult to predict for times in the future, but appropriate bounds can be placed on them.

One assumption commonly made in risk assessments is that at some postulated time after closure of the repository, the radionuclides in the waste are completely dissolved in circulating ground water or that they dissolve at a specific rate. The time required for their movement to the environment is then estimated by assuming that the radionuclides move through surrounding formations along specified paths to the surface. The pathways can be arbitrarily defined, or determined by sophisticated groundwater transport modeling.

Radionuclides dissolved in circulating groundwater can enter the biosphere in a variety of ways, such as discharge of ground water to surface water (e.g., springs, rivers, etc.), and withdrawal of contaminated well water by humans.

Analysis of environmental impact and human uptake of radionuclides can add as much, possibly even more, uncertainty to the evaluation of risk as that associated with release of wastes from the repository and their movement through the subsurface. Surface features, particularly those that might be influenced by humans, such as river flow rates, creation of lakes and dams, and changes in water runoff patterns, can be expected to change more rapidly than subsurface features, and might be less predictable.

Factors directly related to future human actions play a prominent role in determining the effects on humans of released radioactive wastes. One of the more important uncertainties is population density in areas that could potentially become contaminated. Population density could vary from zero to far higher than that now in the most densely populated cities. Furthermore, factors related to water usage are important. For example, irrigation from contaminated river or ground water would significantly increase the contamination of food crops and thus increase the human uptake of radionuclides through food chains. Nevertheless, as with certain geologic and climatic factors, bounds can be placed on the ranges of demographic and other human factors, or comparative consequences assessments can be made by adopting consistent assumptions within which each alternative will be (conditionally) judged.

III. Existing Waste Isolation Safety Evaluations

Nine available studies of waste isolation safety were briefly reviewed while preparing this report. No two of the nine studies reviewed were found to be directly comparable; a variety of analytical models, assumptions, geologic settings, numerical values for physical parameters were used. Only five of the studies addressed the water intrusion scenario, but scenario conditions, assumptions, and results differed as summarized in Table F-1.

Results of the studies are reported in various ways, including increments to radioactivity concentration in the environment, radiation doses to humans, and health effects resulting from radiation doses. Development of a common metric, if possible, is expected to require extensive analysis and cross-comparison. Some of the studies are risk estimates (probabilities and consequences are estimated) and some are consequence estimates only, i.e., the time and circumstances of release from isolation are assumed. Collectively, the studies illustrate the range of methods, assumptions, and results that are possible.

Qualitatively, the studies reviewed can be said to be of three types: optimistic, best-estimate, and worst-case. It is often difficult, however, to classify a given study as it might contain assumptions of all three types. The comparative evaluation suggests, however, the following generalized characterizations of results in the three categories:

- Worst-case studies have predicted adverse effects that can be manifested as measurable increments to radioactivity concentrations in the environment or to radiation dose. Some of the assumptions involved in these studies can be classified as highly conservative.

- Studies classified as best-estimate appear to predict adverse effects that are factors of about ten thousand to one million lower than those for the worst case studies.

- The one study classified as optimistic predicts effects that are vanishingly small. It did not, however, consider phenomena that are acknowledged to be potential causes of radionuclide release from a repository.

Summaries of Studies Reviewed

This section identifies and briefly summarizes the nine studies reviewed. In most cases, results were presented in extensive tables that cannot be readily summarized or reproduced here. Results are therefore expressed as order-of-magnitude estimates derived from the actual information provided by the authors. The interested reader is referred to the original document for details.

1. H. C. Clairborne and F. Gera, Potential Containment Failure Mechanisms and Their Consequences at a Radioactive Waste Repository in Bedded Salt in New Mexico, ORNL-TM-4639, Oak Ridge National Laboratory, Oak Ridge, TN (1974).

This study examined potential containment failure mechanisms and, in some cases, estimated their probabilities and consequences. Two classes of containment failure were considered--anthropogenic and natural. Anthropogenic failure mechanisms include: 1) sabotage, 2) nuclear warfare, and 3) drilling. Sabotage was dismissed as being extremely difficult to effect a release of radioactive wastes from the repository. Nuclear warfare as a means of excavating the waste was dismissed because of the extremely high nuclear yield which would be required. The consequences of drilling into the repository were felt to be minor.

Natural causes of containment failure include meteorite impact, volcanism, faulting, and erosion. Consequences are calculated for meteorite impact and faulting through the repository.

Consequence calculations for meteorite impact and faulting through the repository appear conservative. It is difficult, however, to assess whether the results are conservative (moderate) or optimistic from a risk point of view. Releases resulting from processes and events initiated by the presence of the repository are not considered. These releases could result from shaft seal failure, cracking caused by thermal expansion or subsidence, or other processes. The probability of release by self-induced mechanisms may be higher than the failure probabilities considered in this report.

2. H. C. Burkholder, M. O. Cloninger, D. A. Baker, and G. Jansen, "Incentives for Partitioning High-Level Waste," Nuclear Technology, 31, 202 (1976).

The authors estimated the dose consequences of groundwater transport of radionuclides from a high-level waste repository. The discharge of radio nuclides was assumed to be into a major river. The waste form, the repository, and the surrounding geologic, hydrogeologic, and geochemical environment were analyzed, and the doses were calculated for individuals living within the region of influence of the site at various times after disposal. By varying the values of important parameters, the sensitivity of the dose consequences to the degree of effectiveness of multiple barriers was estimated. The results showed that for "reasonable" isolation conditions the potential maximum incremental radiation doses were of the same order as or less than doses from natural sources.

The parametric variations showed that the dose results were strongly sensitive to the effectiveness of the chemical retardation of radionuclide transport, moderately sensitive to the leach rate of and weakly sensitive to the time when initial contact of groundwater and the wastes occurs particularly after the first 1000 years).

3. H. C. Burkholder, "Management Perspectives for Nuclear Fuel Cycle Wastes, "Nuclear Waste Management and Transportation Quarterly Progress Report January through March 1976, BNWL-2029, Battelle Pacific Northwest Laboratory, Richland, WA (1976).

This study extended the consequence estimations done for high-level wastes by Burkholder et al to other nuclear fuel cycle wastes. The projected maximum incremental doses were of the order of 50 times background or less for spent fuel disposal.

The potential doses from the spent fuel were larger than those from the solidified high-level reprocessing waste because of the increased amounts of uranium and plutonium in the spent fuel which ultimately decayed to the dominant dose contributor, 226 Ra.

4. B. L. Cohen, "High-Level Radioactive Waste from Light Water Reactors," Reviews of Modern Physics, 49, 1 (1977).

This paper is a comprehensive tutorial on the generation, disposal, and time-dependent properties of high-level waste. The estimates of risk are based on a comparison between an atom of waste buried at a depth of 600 m and a typical atom of radium in the rock and soil above the waste canister. The key assumption is that the waste atom is no more likely to escape and find its way to a human than the radium atom. Cohen argues that the assumption is conservative because the material above the waste canister includes near-surface soils where erosion is active. Others would argue that the assumption should be considered quite optimistic because radium is scattered fairly uniformly and is an intrinsic part of the soil and rock, whereas the radioactive waste is high concentrated and located in an area perturbed by excavation of the repository and by the heat from the waste itself. Escape of wastes from the repository would most likely result from those events and processes initiated by the presence of the repository and the radioactive waste.

Cohen further argues that natural delays such as the time required for circulating ground water to contact the waste and the travel time for dissolved waste to reach a discharge location assure that the waste would not reach the environment for the first few hundred years. However, results are presented for releases assumed to occur in the first few hundred years. The calculations predict a new probability that waste from the repository will be ingested by people of 4x10-13 per year. Results were extended to a prediction of less that o.4 waste-caused cancer deaths during the first million years after disposal. The risk results might be increased significantly by other assumptins, e.g., withdrawal of contaminated ground water form a well in the vicinity of the repository.

5. G. deMarsily, E. Ledouns, A. Barbreau, and J. Margat, "Nuclear Waste Disposal: Can the Geologist Guarantee Isolation?" Scienc-, 197 519 (1977).

This study examined the migration of radionuclides from solidified high-level reprocessing wastes in geologic formations. The repository depth was 500 m with water assumed to be present and moving upward. Five geologic media with properties ranging from highly effective to poorly effective in chemical retardation of radionuclides to transport are considered. Results of the study are expressed as concentrations of radionuclides in ground water discharging at the earth's surface. The other major parameter varied in the study is the leach rate of the waste,.

The study combines highly conservative, moderate and highly optimistic assumptions in a way which make classification of the results very difficult. The results probably span the range from conservative to optimistic. Calculations are only performed for I-129, Np-237, and Pu-239 even though, under some assumptionsm, the transfer time to the earth's surface is only a few years. Other actinides, Tc 99, and some shorter-lived fission products should possibly be included to get more comprehensive results.

6. F. Girardi, G. Bertozzi, and M. D'Alessandro, "Long-Term Risk Assessment of Radioactive Waste Disposal in Geological Formations," EUR 5902.e, Commission of the European Communities, Ispra, Italy (1977).

This study performed a fault tree analysis of the potential scenarios for reléase from geologic isolation. It concluded that exhumation of the waste by humans was the most likely scenario for the first 100,000 years and ground water intrusion and dissolved waste transport were estimated but no chemical retardation of radionuclides was assumed. The maximum projected doses were in the order of 2-5% of natural radiation sources, for high-level wastes. TRU wastes were also included in the study and were found to cause slightly high doses. Results for high-level waste are summarized in Table F-1.

7. M . D. Hill and P. D. Grimwood, "Preliminary Assessment of the Radiological Protection Aspects of Disposal of High-Level Waste in Geologic Formations," NRPB-R69 National Radiological Protection Board, Harwell, U.K. (1978).

This study estimated the dose consequences for the groundwater intrusion scenario for the same set of conditions as those of Burkholder et al. The assumed initial waste inventory was about 10 times smaller, however, and different modeling techniques were used for bojth transport in the geologic environment and the biosphere. The maximum projected doses were on the order of 2 to 5% of natural radiation sources.

Sensitivity calculations were performed for five of the geologic environment transport parameters. These calculations showed that both the nuclide transport and leach resistances were important controllers of the projected doses for the situations investigated. Results are summarized in Table F-1.

8. Nuclear Fuel Safety Group, "Handling of Spent Nuclear Fuel and Final Storage of Vitrified High-Level Reprocessing Waste, "Karn - Bransle - Sakerhet, Stockhol, Sweden (1978).

The Swedish Nuclear Fuel Safety Group estimated the dose consequences of groundwater intrusion into the radionuclide transport from high-level waste repository in Swedish granite. Three types of discharge to the biosphere was assumed: 1) lake, 2) underground well, and 3) Baltic Sea. The assumptions made for the calculations were thought to conservatively represent Swedish conditions. Transport of radioactivity through the geologic environment was modeled using a variant of the computer code applied by Burkholder et al; projected doses were greatest in the well case with values on the order of one-tenth of natural radiation sources. Results are summarized in Table F-1.

9. S. E. Logan and M. C. Berban, Development and Application of a Risk Assessment Method for Radioactive Waste Management, EPA 520/6-78-005 U.S. Environmental Protection Agency Office of Radiation Programs; Washington, DC (1978).

The study devoted significant effort to determining radiation dose rates. From a consequence standpoint the results would appear to be conservative. However, from a risk point of view, it is difficult to determine whether the study is conservative or optimistic. For example, the scenarios considered are incomplete. Scenarios such as release to ground water via mine shaft or repository shaft leaks, or deliberate or accidental penetration of repository by drilling are not considered.

The use of fault tree analysis to represent the various geologic events makes it necessary to estimated event probabilities and estimated release fractions which are not, in general, justifiably accurate.

Interpretation of Available Results

One possible conclusion that can be drawn from available studies is that none precludes reasonable assurance of obtaining an adequate level of safety. In fact, they suggest that the risks will be quite small. For the worst cases envisaged and studied to date, hazards would be discernable but small. A close examination of the boundary conditions utilized in the six studies that considered groundwater transport can however lead to the opposite conclusion. For example the two Burkholder studies (Table F-1), and the Hill and Grimwood study which used the same conditions as did Burkholder, assumes that the ground water from the repository discharges into a major river (10,000 cubic feet per second flow) with an attendent several orders of magnitude dilution of radionuclide content. The discharge cited is comparable to the mean annual discharge rate of the Delaware River at Trenton, N.J., and indeed, if such a boundary condition persists over the time frames cited in Table F-1 (up to 2,100,000 years) then a highly effective mechanism for waste dilution exists. However, over time frames of even tens of thousands of years, and as a result of erosion or tectonics, several plausible conditions

TABLE F-1

SUMMARY OF WATER INTRUSION SCENARIO STUDIES

REFERENCE	SCENARIO	TIME OF INITIAL RELEASE AFTER CLOSURE (yr)	LEACH TIME (yr)	GROUND WATER TRAVEL TIME TO BIOSPHERE (yr)	RETARDATION FACTOR (V_{water}/V_{nuc})	REPOSITORY NUCLIDE INVENTORY (Ci)	CRITICAL NUCLIDE	50-Yr ACCUMULATED DOSE TO INDIVIDUAL (m rem)	CRITICAL ORGAN	TIME AFTER CLOSURE THAT DOSE IS RECEIVED (yr)
Burkholder et al	High-Level; Leach Incident; Discharge to river	100	30,000	150	1 10 100 500	2.86×10^6 1.03×10^6 8.07×10^6 0.347	^{99}Tc ^{14}C ^{237}Np ^{226}Ra	260 3,000 120 2,400	GI-LLI Bone Bone Bone	250 1,700 15,000 2,100,000
Burkholder et al	Spent Fuel; Leach Incident; Discharge to river	Same as Above	3,000	Same as Above	Same as Above	Same as Above	Same as Above	2,600 30,000 1,200 240,000	Same as Above	Same as Above
Swedish Safety Study	High-Level; Leach Incident; Discharge to well	1000	30,000	400	1 700 43 260	140×10^3 20 750 6400	^{99}Tc ^{226}Ra ^{233}U ^{237}Np	150 130 130 650	GI-LLI Bone Bone Bone	13,000 80,000 80,000 120,000
Girardi et al	High Level; Leach Incident; Discharge to river	1000	17,000	0	-0-	5.3×10^6 5.2×10^5	^{241}Am ^{243}Am	100 250	Bone Lung	1,000
Hill and Grimwood	High-level; Leach Incident; Discharge to river	1000	3,500	100	1 100 500	1.6×10^5 1.2×10^4 ?	^{99}Tc ^{237}Np ^{226}Ra	5% MPAI 3% MPAI 2% MPAI	GI-LLI Bone Bone	100 ? ?

unfavorable to radionuclide dilution and perhaps even favorable to nuclide concentration could occur. For example, a large marsh might exist at the location of the present river with the attendent possibility of radionuclide concentration by aquatic food chains. Similarly the flow of the river could decrease significantly over such time frames, or the groundwater flow be diverted away from the river. Additionally, the Burkholder studies do not consider the possibility of human use of, and radionuclide concentration in ground water between the repository and the major river.

The model studies summarized unquestionably are useful in that they provide an appreciation for the inter-relationship and importance of the numerous hydrogeologic, geochemical, rock mechanic and engineering parameters affecting the behavior of radionuclides placed in a repository. Conclusions drawn from such studies are valuable to the degree that the boundary conditions used and the uncertainties of data input and output are clearly stated. Whether or not conditions at a potential repository site match favorable hypothetical scenarios modeled must of course await detailed site specific studies.

APPENDIX G

International Programs in Nuclear Waste Management

Although the problem of waste management is universal to the nuclear community, the technical approaches and programs of execution are in the main national in approach and execution. Waste management research and development is being supported by the respective governments through their atomic energy organizations or through government affiliated companies such as BNFL (UK), COGEMA (France), CEN (Belgium) and PNC (Japan).

International cooperation takes place through: international organizations such as the International Atomic Energy Agency; the Commission on European Communities (CEC); the Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development (OECD); combines such as United Reprocessors and through bilateral agreements.

The CEC has established a comprehensive program of radioactive waste management technology development. This program is being conducted in various laboratories throughout the European Community. It parallels in some ways the U.S. program, however, it is based on the assumption that spent fuel will be reprocessed. The program includes investigation of the suitability for final disposal of various types of formations in the UK, France, Belgium, Italy, Germany and Holland.

The International Atomic Energy Agency (IAEA) provides a multinational focus for investigation and development in the waste management area. The activities are carried out through technical meetings and research contracts dealing with a broad range of radioactive waste problems as well as through the development of health and safety standards to serve as examples for national regulations.

The IAEA organizes annual meetings of countries actually working in or working toward large-scale waste management programs. One of these is a group called the "International Working Group for High-Level Waste and Transuranium (Alpha) Waste." The meeting agendas usually include a mixture of policy and technical discussions. A panel is developing criteria for the selection and operation of long-term high-level waste disposal sites and practices for storing and disposing of high-level wastes. Another panel is developing recommendations concerning disposal of high-level radioactive wastes unsuitable for dumping at sea.

The U.S. is a member of the Radioactive Waste Management Coordinating Committee of the NEA. This Committee holds regular meetings which serve as a catalyst for activities in the waste management area.

At the present time, the United States has bilateral agreements in the waste management field with Canada, West Germany, Sweden and an agreement with Belgium is currently under consideration. In addition the U.S./U.K. Fast Breeder Reactor Exchange Agreement provides for possible cooperation in this field. However, based on U.S. nonproliferation policy, exchanges are limited to transuranic waste processing and decontamination technology.

The Swedish agreement provides for a specific limited scope cooperative program for field-testing experiments and techniques relative to measuring fluid movement through fractures in a granite rock system, utilizing the Stripa Mine in Sweden. These results will provide data useful for evaluating U.S. granite as a terminal storage repository and will also provide techniques for making measurement on U.S. formations.

The Canadian, German, and U.K. agreements are general in nature and provide for the mutual exchange of technical and scientific data, information, and personnel plus collaboration on joint projects.

The scope of the agreements cover waste management aspects of the entire fuel cycle, specifically:

- High-level waste solidification and packaging
- Treatment and packaging of intermediate and low-level waste
- Treatment of transuranic waste
- Trapping and storage of gases
- Evaluation of alternative disposal concepts
- Decommissioning of nuclear facilities
- Operating experience for low-level waste
- Information and data on disposal in geologic media

Information on fuel reprocessing or waste management processes that require reprocessing or plutonium recycle for implementation has been withheld in conformance with the U.S. nonproliferation policy. This was a unilateral action on the part of the U.S.

Experience with the Canadians has been in the exchange and cooperative projects associated with geologic disposal and retrievable surface storage data.

Information exchange with West Germany has been quite extensive, with exchanges recently being limited to disposal techniques, transuranics, and collaboration on salt repository work, due to our non-proliferation policy.

Only a few countries presently have the actual problem of the disposal of radioactive wastes resulting from the operation of reprocessing plants. This includes those countries that have significant reprocessing programs such as the UK and France. In the future other countries that are planning to reprocess their spent fuel such as the FRG and possibly Japan will be faced with this problem as will those countries that have made commitments to take back the wastes resulting from the reprocessing of their spent fuel by others.

Following are summaries of waste management programs of countries with significant efforts in this area.

United Kingdom

The UK has been reprocessing Magnox fuel at Windscale from its domestic gas cooled reactors on a regular basis for about ten years at a rate of approximately 1000 metric tons per year. Fuel from the two gas cooled reactors exported to Italy and Japan is also being reprocessed at Windscale.

In addition to the reprocessing of domestic fuel the UK plans to reprocess LWR fuel from other countries. To handle this fuel, the UK is planning to construct a 1000 metric ton per year plant, to be completed in the mid to late 1980's. The UK Department of Environment completed an inquiry resulting in approval of the proposed plant.

The high level wastes from the reprocessing operation are presently being stored in liquid form in doubled walled steel tanks.

The development of waste processing technology within the UK covers high-level waste, transuranic or alpha contaminated waste, and airborne waste. The UK plan is to store high-level liquid waste for the interim and then to convert it to borosilicate glass. A pilot vitrification plant is now under construction.

The UK is a member of United Reprocessors GMBH which is a combine of UK, France and West Germany entities to service primarily European commercial fuel reprocessing requirements.

The UK has an ongoing program to evaluate the concept of terminal isolation of radioactive waste in geological formations. In the UK it seems likely that there are two options, clay formations and granite.

France

France has been reprocessing domestic power reactor fuel from its graphite moderated gas cooled reactors since 1959. This reprocessing was originally accomplished at Marcoule and more recently at La Hague. A new front end facility to accommodate LWR fuel at La Hague started operation in early 1977.

The French are also equal partners with the British and West Germans in United Reprocessors GMBH (URG). The French shareholder, originally the French Atomic Energy Commission (CEA) and now COGEMA, (a government owned corporation) operates the reprocessing plants at Marcoule and La Hague. They plan to operate these plants at a low rate in 1978 and plan gradual increases in capacity, reaching 800 metric tons uranium per year by the mid 1980's. In addition, COGEMA plans a third reprocessing plant, to be built at La Hague, with two similar reprocessing lines each of 800 metric tons uranium capacity per year. These two lines are planned to come on stream during the mid to late 1980's.

COGEMA, under United Reprocessors auspices, is offering long-term contracts for storage and reprocessing services for 6,000 metric tons of irradiated fuels.

Reprocessing wastes have been stored in liquid form in engineered storage facilities. However, the French have started operation of their AVM plant (150 cubic meter capacity) at Marcoule for the continuous vitrification of high level wastes. Another such plant (AVH) for La Hague with a capacity of 800 cubic meters per year is now being designed and scheduled for completion in the early 1980's. Marcoule has an air-cooled underground facility for interim storage of AVM waste glass.

The planned disposal method for alpha-bearing wastes is emplacement in deep geological formations. For fission products, either geologic disposal or long-term storage in engineered facilities is a possible solution. The formations presently being studied for geologic disposal are rock salt and granite. The reconnaissance of salt formations in France has indicated the existence of several promising areas. However, present plans are to devote a significantly greater effort to granite formations.

The possibility of disposal in granite has been evaluated for the La Hague site.

Plans are also under way for an extensive program that will evaluate many other granite formations existing in France. This program will be partially financed by the Commission of European Communities. The target date for the first pilot-plant repository (alpha-bearing waste only) is 1985.

Canada

The CANDU nuclear power system, based on a high neutron economy natural uranium fuel cycle, currently closes with secure retrievable storage of spent fuel until such time as processing to recover the plutonium is economical. Future development of the CANDU system is focused on conversion to plutonium and thorium recycle fuel cycles.

The majority of the Canadian current waste management interest is on interim spent fuel storage concepts and packaging designs. Since reprocessing of fuel may eventually become a requirement, the Canadians are becoming interested in developing a reprocessing capability for the CANDU thorium U-233 fuel cycle, including waste processing.

The Canadians recognize that if they decide to reprocess their spent fuel geologic terminal storage of high level waste from reprocessed fuel will be necessary and therefore they are engaged in efforts to find suitable geologic formations for both secure retrievable storage and terminal storage. The Canadians have followed the U.S. geologic program closely using the logic that they have the same formations as the U.S. and if a need for disposal capability should arise, they could use technology developed and demonstrated here. However, since the Canadian Geologic Survey has become more actively involved a more independent approach is evolving. While they are continuing to stay abreast of salt technology, they are concentrating on the investigation of granite formations.

In 1977 Canada's Department of Energy, Mines and Resources commissioned a group of independent experts to study the long term storage of radioactive wastes. This study was completed in August 1977 and the results published in a report entitled "Management of Canada's Nuclear Wastes".

The study group recommended that the Canadian Government develop a draft plan that should be submitted for Federal provincial discussions that would lead to its adoption as a national plan.

The group concluded that the prospects were good for the safe, permanent disposal of reactor wastes and irradiated fuel in geologic repositories since they foresaw no environmental or health impacts once these radioactive materials have been placed in carefully selected repositories.

They considered underground disposal in igneous rock as the most promising Canadian option for the disposal of spent fuels and radioactive wastes. Also, that initially one repository will suffice, and that the repository chosen should be regarded as a central national facility, Federally owned and operated and available to all provincial utilities. The cost of building and operation should be recovered via charges from the organizations from whom the waste is received.

The group also concluded that spent fuel reprocessing is not necessary for safe disposal - both spent fuel and immobilized reprocessing waste can be disposed of in the same repository, and that no commercial fuel reprocessing plant should be approved in Canada until satisfactory methods for dealing with the associated radioactive wastes have been developed.

Finally, the group concluded that the ongoing Canadian research and development program in this area was well conceived but that it should be given greater priority and increased financial support, especially in the areas of geological, geophysical, geochemical and engineering research required for the geological formation disposal sites.

Japan

In Japan more than fifteen nuclear power plants of industrial scale are now in operation and some other ten plants are under construction or in the planning stage.

Japan has a 210 metric ton per year reprocessing plant at Tokai Mura that began limited operation in the Fall of 1977 and reportedly has intentions to build a 1500 ton per year plant for operation in the 1990's. To alleviate the spent fuel situation, in the meantime, consideration is being given to construction of a centralized away from reactor, spent fuel storage pool. They also have a reprocessing contract with United Reprocessors (COGEMA) and one with BNFL.

The waste management program in Japan is coordinated through the Atomic Energy Bureau. The high-level liquid waste from the pilot reprocessing plant they have purchased from France will be stored initially as acid liquid in stainless steel tanks pending a decision on solidification or more sophisticated processing treatment, such as partioning and transmutation which the Japanese have studied in some detail.

Japan does not permit the land burial of radioactive wastes at the present time. However, they are evaluating a number of sites for possible use. These are either at nuclear laboratories or nuclear power plants sites. Since Japan has no terminal storage capability, low-level waste is currently being mixed with cement in drums and stored in warehouses and underground concrete trenches.

The Japanese research and development activities include research at Tokai Mura on a waste immobilization process involving calcination of wastes and subsequent sintering, pressing, or melting of the calcined product. A waste immobilization demonstration facility is to be constructed, with operation scheduled for 1986.

The Science and Technology Agency is sponsoring an extensive program to develop geologic disposal sites in Japan for high-level wastes. The Japan Atomic Energy Research Institute (JAERI) is conducting the safety studies. Under sub-contract with JAERI, Mitsubishi Metals Corporation is making a survey of Japan for potential sites. Their preliminary report, issued in 1977, identifies geological bodies of granite and zeolite rock as attractive possibilities, and suggests further consideration of limestone, diatomite and shale formations.

The Japanese are also interested in regional arrangements for activities associated with the backend of the fuel cycle and in seabed as well as island disposal concepts.

Germany

The Federal Republic of Germany has an extensive nuclear power program, however, unlike its partners in United Reprocessing the French and the British, it does not have an existing spent fuel reprocessing capability except for the small WAK 40 MT/yr experimental reprocessing facility located at Karlsruhe. The FRG has a commitment from their French United Reprocessing partner, COGEMA, to reprocess all uncommitted German fuel discharged through 1981.

The FRG is heavily committed to spent fuel reprocessing and eventual geologic disposition. In fact, approval of reactor construction licenses have been contingent on the Radiation Protection and Reactor Safety Commission's approval of a reprocessing and waste disposal complex. Recently these two Commissions concluded that the feasibility of such a concept is proven from a safety and technological point of view.

The German nuclear industry and political and governmental circles feel that in order to gain public acceptance of nuclear power they must prove that nuclear wastes can be handled and disposed of safely. The classic FRG position to date has been that reprocessing is an essential precondition to effective disposal of radioactive wastes. It is also important to them that nuclear power, including the backend of the fuel cycle, must be successfully demonstrated domestically in order to demonstrate to the world nuclear export market that German industry has the technical and management resources required for both converter and breeder reactor systems.

The FRG does not expect to have its first commercial reprocessing plant in operation until the late 1980's. This is expected to be a 1400 metric ton per year plant to be located at Gorleben in Lower Saxony. The Germans plan to concentrate reprocessing, recycling and disposal of fissionable material, waste handling treatment and storage at Gorleben. It is also their plan to solidify their high level waste and to place it in intermediate storage in retrievable form to allow sufficient time to develop and demonstrate a final disposal system in geologic formations.

As a result of reactor storage pool size restrictions and the distant dates for the operation of the reprocessing plant, the government plans to construct large scale, away from reactor, storage pools (3500 MTU capacity by 1989) to be located at the eventual reprocessing site.

Waste processing technology in the FRG is being developed for treating high-level, alpha contaminated, intermediate-level, and airborne waste. The German plan for high-level liquid waste disposal involves spray calcination and vitrification.

The Germans are recognized as one of the world's leaders in the disposal of radioactive waste. They have a salt mine located at Asse which is receiving waste on a routine basis much like a scaled-down version of the pilot plant for DOE defense waste in New Mexico. Their Asse salt mine is limited to waste having a low transuranic content and is not intended to serve as the major fuel reprocessing waste disposal facility.

Belgium

Belgium presently has three operating power reactors and another four planned for operation by 1982. Currently none of the fuel from these reactors is committed for reprocessing. Reportedly, Belgium is planning to expand the storage pools at some of the reactor sites.

Until July 1974, the Eurochemic reprocessing plant was operated a Mol, Belgium as a multinational pilot venture. At that time it was shut down as uneconomic. The Belgium government is now considering refurbishing, upgrading, and reopening that plant by mid 1981. Its capacity would be devoted to Belgium needs. Reportedly the plant would be brought up to full 300 MTU/year capacity over a 3 to 4 year period.

The Belgium government's proposed Waste Management Research and Development 5 Year Plan for 1978-1982 includes work to be done mostly under the framework of the Commission of European Communities, in the following areas: Radioactive waste burial in geologic formations; studies of compaction and encapsulation of cladding waste; investigation of high temperature incineration of plutonium containing waste; and purification of gas released from reprocessing operations.

A waste management technical exchange agreement with the U.S. is now under negotiation. The proposed areas of cooperation are: terminal storage in geological formations; technology of retrievable storage; high-level waste solidification and environmental effects of radioactive waste disposal.

Sweden

Sweden currently has 6 LWR plants in operation, two more expected to begin operation shortly and a total of ten to thirteen reactors are expected to be in operation by 1983.

A law (the Stipulations Law) has been enacted in Sweden stating that, prior to a permission for operation could be given by the Government, the owner of a nuclear reactor must either provide a valid reprocessing contract and demonstrate how and where a final deposition of the high-level waste from reprocessing of spent nuclear fuel can be effected with absolute safety, or to demonstrate how and where the final deposition of spent unreprocessed nuclear fuel could be effected with absolute safety.

In 1976 a waste management policy committee chartered by the government recommended that Sweden develop a reprocessing and waste management capability. With the recent change in government, emphasis is being placed on external reprocessing with a major research and development effort directed toward the disposal of nuclear wastes in Sweden. However, the Swedish government has indicated that they will not have their fuel reprocessed until the completion of the International Nuclear Fuel Cycle Evaluation Program.

The present waste management strategy is to store solidified waste or unreprocessed spent fuel in granite or gneiss foundations. Therefore, waste management research and development is directed toward this end. The present program includes:

- o Ion exchange processes for fractionation of high-level liquid wastes and collection of radionuclides in solid form.
- o Powder-pressing and sintering techniques for making waste glass forms and for making ceramic containers for spent fuels.
- o Design of underground spent fuel storage pools.
- o An extension of the existing feasibility oriented program to a development, optimization and design oriented program aiming at a completed final repository at year 2020.

Recently, a utility group has completed design studies for the application of a siting license for a central storage facility for spent nuclear fuel in Sweden. The application was filed in October 1977. Construction is intended to start in 1979 and the facility would then be ready to receive fuel in 1984.

Another utility group, the KBS-Project, has issued reports concerning the final storage of both high level radioactive waste and spent nuclear fuel. The reports are produced in order to fulfill the requirements of the Stipulations Law.

Two nuclear power stations are now on stand-by for fueling, awaiting the Government decision on whether the requirements in the Stipulations Law have been met.

USSR

It is estimated that the USSR will have on the order of 20,000 MWe of nuclear power generating capacity on line by the early 1980's. The USSR has a significant LMFBR program and is committed to the plutonium breeder cycle.

According to available information, the Soviet Union does not have a commercial-scale spent fuel reprocessing plant on line but is reportedly buildilng one with a 5 metric ton per day capacity, to be operational in the early 1980's. A vitrification plant to be located near the reprocessing plant is also projected.

The USSR has an experimental high level waste solidification program. They have a pilot vitrification unit using a single stage phosphate glass process that has been operating for several years. They have also been working with a two stage fluidized bed calcination process.

In the area of high level waste disposal, studies of geologic isolation have been conducted, however, they presently seem to emphasize surface storage for solidified high level wastes.

India

Presently India has three power reactors in operation. Two are 200 MW electric light water reactors and one 200 MWe pressurized heavy water reactor. Another pressurized heavy water reactor is expected to go critical shortly and four more are under construction.

India currently has a 60 metric ton per year reprocessing plant at Trombay capable of reprocessing uranium metal or uranium oxide fuels. A 100 metric ton per year plant, built primarily to handle light water reactor fuel from the Tarapur Atomic Power Station, has also been completed.

The Bhabha Atomic Research Center at Trombay has developed a pot calcination process for their high level wastes. Also a waste solidification plant is being constructed at Tarapur.

Reportedly the high population density and limited transport facilities of India have led to a national policy to construct small-capacity fuel reprocessing-waste solidification-interim waste storage complexes at several locations, rather than to establish a centralized, large-capacity plant.

Work is underway on geologic waste disposal technology and on the selection of a site for India's radioactive wastes. In India, because of the lack of suitable evaporites deposits, the choice is restricted to igneous rock formations, and selected sedimentary deposits. This will present difficult problems of mining in the hard rock formations with the consequent effect on the economics of waste disposal. Evaluations are under way for assessment of various geological formations in selected non-seismic zones of the country. Data on geological and hydro-geological characteristics of the above formations, the physical and chemical properties of the rock and climatological and seismic data are being collected, in coordination with various field agencies. Compilation, correlation and analysis of the data to screen and identify possible areas of location of repository sites are underway prior to taking up of detailed site investigations.

Appendix H

Summary of Draft Report

"The waste generated by nuclear power must be managed so as to protect current and future generations."

With these words in his April 1977, National Energy Plan, President Carter signaled his determination to develop a national nuclear waste management policy and program. Recognizing the numerous Federal agencies, as well as State and local interests, involved in such a program, the President established an Interagency Review Group (IRG) and charged it with developing a strategy for dealing with the waste management problem.

In carrying out the Presidential mandate, the IRG has attempted, by a variety of means, to obtain a broad range of inputs and views from many sources, including Congress, State and local governments, Indian nations, industry, the scientific and technical community, public interest and environmental organizations, and the public.

This draft report presents the tentative findings of the IRG, based on consideration of the possible strategies which have been identified for managing nuclear wastes, and is issued for comment by members of the public. When these comments have been received, reviewed and incorporated, as appropriate, the report will be forwarded to the President for his consideration and guidance for further action.

BACKGROUND

Waste consists of radioactive species of almost all chemical elements; some contain naturally occurring radioactive materials and others contain man-made radioactive materials; the wastes exist as gases, liquids, and solids. Yet for all their variety, radioactive wastes have one thing in common: as long as they remain highly radioactive, they will be potentially hazardous. This potential hazard results from the fact that exposure to and/or uptake of radioactive material can cause biological damage. In man, it can lead to death directly through intense exposure and a variety of diseases, including cancer, which can be fatal. In addition, radioactive material can be mutagenic, thereby transmitting biological damage into the future.

The central scientific fact about radioactive material is that there is no method of altering the period of time in which a particular species remains radioactive, and thereby potentially toxic and hazardous without changing that species. Only with time will the material decay to a stable (nonradioactive) element. The pertinent decay times vary from hundreds of years for the bulk of the fission products to millions of years for certain of the actinide elements and long-lived fission products. Thus, if present and future generations are to be protected from potential biological damage, a way must be provided either to isolate waste from the biosphere for long periods of time, to remove it entirely from the earth, or to transform it into nonradioactive elements.

The management of radioactive wastes for the past three decades can be characterized by inadequate integration of waste management R&D efforts with those for other parts of the nuclear fuel cycle. This has been caused in part by inadequate perceptions of the additional technological and scientific capabilities needed to develop an acceptable disposal capability (historically assumed to be achievable through isolation of wastes in mined geologic repositories) and in part by low funding levels compatible with a view that the waste management program should focus on only one geologic medium (salt) for HLW disposal and few sites.

With time, it has become clear that prior concentration on engineering solutions with minimal earth and materials science input has been too simplistic. It is now recognized that a much more broadly based program which addresses fundamental scientific questions within a systems concept is needed; in particular, one which emphasizes flexibility in programmatic and repository design to permit disposal of all types of existing and future radioactive wastes.

RELATIONSHIP TO NUCLEAR POWER

The question of the impact of nuclear waste concerns on the future of nuclear power is quite complex and has not been conclusively addressed at this juncture by the IRG. The IRG is aware that strongly held and differing views on the subject exist. Therefore, the IRG has adopted the following approach for purposes of its Report:

- The President should be informed of the nature and intensity of the public views on this issue;

- The IRG's analysis and recommendations address the nuclear power future neutrally in the following three ways:

    - The substantial existing inventory of civilian and military nuclear wastes must be managed in the safest possible way and must be subject to the same strict safety criteria applicable to newly generated wastes, despite pressures to be more lenient towards existing wastes.

    - The IRG has reviewed the dimensions and implications of the radioactive waste issue from the standpoint of alternative nuclear growth futures.

- The IRG has taken care that its conclusions and recommendations are viable, whatever the future course of nuclear power growth, and are neutral as to alternative nuclear futures.

o An orderly, step-by-step decision-making process that ensures consideration of all facets of the issue and pays maximum attention to the public health and safety should be followed in the development of the policy, plan and program for nuclear waste management.

Public comment is particularly welcomed on the relationship between waste management concerns and the future of nuclear power.

INTERIM STRATEGIC PLANNING BASIS

It should be made clear that a number of different approaches to nuclear waste management are possible. There will be a continuing need for flexibility in planning as well as an opportunity to adjust the program to reflect the results of new developments in both the technical, social, and institutional areas of nuclear waste management. Not all decisions can or should be made now. However, a clear interim strategic planning basis must be set forth to develop near-term waste management programs, assign priorities, and plan R&D programs prior to completion of the NEPA (National Environmental Policy Act) process and selection of a strategy.

Such an approach is required to ensure that, taken as a whole, this country is moving along a course which, at its conclusion, will permit implementation of a nuclear waste management program meeting basic environmental and safety requirements in a manner which is socially acceptable, economically feasible, and consistent with general nuclear policies.

Implementation of an overall strategic planning basis will involve a series of major decision points based on environmental reviews, standards setting and licensing procedures, R&D findings, State and local decisions, and Congressional actions. Successful implementation depends on satisfactorily passing such points, and failure to do so, whether because of technical limitations, policy constraints, or timing difficulties, would require modification of the strategy approach selected.

This IRG Report emphasizes the following topics:

o Proposed Objectives for Nuclear Waste Management

o Technical Findings and Conclusions

o Tentative Policy Recommendations (including issues not yet resolved by the IRG during its deliberations)

o Implementation Recommendations

- o Legislative Requirements
- o Work Plans

These are summarized, in turn, below.

PROPOSED OBJECTIVES

The primary objective of waste management planning is to provide assurance that:

- o Existing and future nuclear waste from military and civilian activities (including discarded spent fuel from the once-through nuclear power cycle) can be isolated from the biosphere, and pose no significant threat to public health and safety.

The national nuclear waste management policy, plan, and program must meet additional key subobjectives:

- o The selected technical options must meet all of the relevant radiological protection critiera as well as any other applicable regulatory requirements; although zero release of radionuclides or zero risk from any such release cannot be assured, such risks should be within preestablished standards, and beyond that, be reduced to the lowest level practicable.

- o The responsibility for establishing a waste management program shall not be deferred to future generations. Moreover, the system should not depend on the long-term stability or operation of social or governmental institutions for the security of waste isolation after disposal.

- o The capability to deal with a wide range of alternative situations in the future must exist. The basic elements of the program should be independent of the size of the nuclear industry and of the resolution of specific fuel-cycle or reactor-design issues of the nuclear power industry.

- o Appropriate cost of storage and disposal of any waste generated in the private sector should be paid for by the generator and borne by the beneficiary; budgetary and cost considerations, while important, should not dominate the design of the program or system.

TECHNICAL FINDINGS AND CONCLUSIONS

Because of the need to isolate High-Level Wastes (HLW) and Transuranic (TRU) waste from the biosphere for relatively long periods of time, and because disposal in mined repositories is the nearest term option, the IRG carefully reviewed the present status of scientific and technological knowledge pertinent to mined repositories. The IRG review identified a number of important technical findings which it believes to represent the views of a majority of informed technical experts:

- A systems approach should be used to select the geologic environment, repository site, and waste form. A systems approach recognizes that, over thousands of years, the fate of radionuclides in a repository will be determined by the natural geologic environment, by the physical and chemical properties of the medium chosen for waste emplacement, by the waste form itself, and other engineered barriers. If carefuly selected, these factors can and should provide multiple, and to some extent independent, natural and engineered barriers to the release of radionuclides to the biosphere.

- Overall scientific and technological knowledge is adequate to proceed with region selection and site characterization, despite the limitations in our current knowledge and modeling capability. Successful isolation of radioactive wastes from the biosphere appears technically feasible for periods of thousands of years provided that the systems view is utilized rigorously.

- Detailed studies of specific, potential repository sites in different geologic environments should begin immediately. Generic studies of geologic media or risk assessment analyses of hypothetical sites, while useful for site selection, are not sufficient for some aspects of repository design or for site suitability determination.

- The actinide activity in TRU wastes and HLW suggest that both waste types present problems of comparable magnitude for the very long term.

- The degree of long-term isolation provided by a repository, viewed as a system, and the effects of changes in repository design, geology, climate, and human activities on the public health and safety can only be assessed through analytical modeling.

- The effects of future human activity must be evaluated more carefully.

- Reprocessing is not required to assure disposal of commercial spent fuel in appropriately chosen geologic environments. Moreover, current United States repository designs are and will continue to be based on the ability to receive either solidified reprocessing waste or discarded spent fuel as a waste material. The question of whether commercial reprocessing will be initiated in the United States, while an important issue, is therefore not fundamentally related to the issue of safe waste disposal.

Because the necessary isolation periods for waste disposal are so long, no demonstration can prove the presumption of safety. Thus, a social consensus, based on scientific evidence, must be obtained through:

- o Dissemination of fundamental scientific information.
- o The development, analysis, and near-term validation of long-term predictive models.
- o Extensive, independent, objective review of results by scientific experts, and of proposed facilities and operations through the licensing process.
- o Practical experience, including careful monitoring of the isolation systems.
- o A demonstrated capability to take any needed corrective or mitigating actions.
- o An ongoing R&D program to increase the state-of-the-art of knowledge.

Only if such a social consensus is obtained, can disposal of HLW and TRU waste in geologic formations actually be implemented and the public be confident that nuclear waste can be safely isolated in this way over very long periods of time.

With respect to other waste types, technologies exist for the managment and disposal of Low-Level Waste (LLW), uranium mill tailings, and for waste from Decontamination and Decommissioning (D&D). However, existing practice must be improved considerably to further reduce the potential for public hazard associated with these materials.

Most LLW, which is found in a wide variety of forms, remains radioactive for up to several hundred years. The current means of disposing of this waste is through shallow-land burial. Radionuclides in low concentrations have migrated from the burial trenches at a few LLW sites. Studies to date conclude that such migration does not pose any present significant threat to public health and safety. Monitoring of future radionuclide migration from those sites over periods of decades should be considered as a potential regulatory requirement. In the future, siting of LLW disposal facilities should give much greater attention to the hydrologic characteristics of proposed locations than has been the case in the past. NRC and DOE should take appropriate action to assure that this occurs.

Numerous technical approaches to LLW disposal have been proposed as alternatives to conventional shallow-land burial. Some of these require only a decision to use them and location of a suitable site to be implemented immediately. Others require additional technology development and perhaps demonstration before their feasibility and safety could be assured. R&D for improved methods of shallow-land burial of LLW and of alternative methods of disposal should be accelerated because shallow-land burial, as currently practiced, may not be an adequate disposal method for all LLW in the future.

Compared with other types of nuclear waste, uranium mill tailings are generated in large volume, about 10-15 million tons annually. Although tailings are a natural product of mining amd milling, they are hazardous because they contain long-lived radioisotopes and because they have been left in waste piles where humans may come in contact with them.

The relative magnitude of actinide elements in mill tailings, HLW, and TRU wastes, per unit of energy generated, suggests that these waste streams may present problems of comparable magnitude for the very long term, that is, beyond a period of a thousand years. By virtue of their presence at the surface, the actinide elements in mill tailings may constitute a greater potential problem that those in deeply buried HLW and TRU wastes. Thus, disposal of these tailings must be managed as carefully as that for the HLW and TRU wastes.

TENTATIVE POLICY RECOMMENDATIONS

Licensing

All commercial nuclear activities and facilities, except those that involve minimal quantities of special nuclear materials are subject to licensing by the NRC. Congress has also considered the matter of which DOE facilities should be subject to licensing and present legislation designates the following DOE waste disposal and handling facilities:

- o Facilities used primarily for the receipt and storage of high-level radioactive waste produced from licensed activities.
- o Facilities authorized for the express purpose of subsequent long-term storage of high-level radioactive waste generated by DOE which are not used for, or are part of, R&D activities.

However, the question of whether or not to license other DOE waste facilities continues to be a matter of public discussion.

The IRG considered the following three alternative options to define the degree of licensing coverage appropriate for DOE facilities:

1. The status quo, as contained in existing legislation,

2. An extension of NRC licensing authority (requiring new legislation) primarily to incorporate licensing of new DOE facilities for disposal of TRU waste and nondefense low-level waste, or

3. A further extension of NRC licensing authority to incorporate all new DOE post reprocessing waste facilities and interim storage as well as disposal of waste from both the defense and nondefense programs.

All members of the IRG recommend that an extension of licensing to the degree associated with alternative No. 2 above be adopted and that the DOE submit appropriate legislation to the Congress to accomplish it. Some members of the IRG, believe that a still further extension beyond alternative No. 2 may be warranted.

Whether licensed or not, all DOE waste management activities will be subject to EPA general criteria for radioactive waste and EPA numerical standards for specific waste types.

The IRG particularly welcomes public comment on the proposed extent of licensing and to what degree, if any, further extension would be appropriate and desirable.

Disposal of High-Level Waste

Technical strategies for the disposal of high-level radioactive wastes can be based on a number of technological options. For example, technological options include placement in mined geologic repositories, placement in deep ocean sediments, and ejection into space. For placement in mined geologic repositories, a choice among a number of geologic environments possessing a wide variety of emplacement media such as salt, shale, or granite, is possible.

The choice of technical strategies for the disposal of HLW and its implementation must await completion of the appropriate generic environmental impact statement required by the National Environmental Policy Act (NEPA). However, because near term waste management programs must be developed, priorities assigned, and R&D activities planned prior to the completion of the NEPA process and the selection of a strategy, a clear, interim strategic planning basis must be set forth. It must be designed and executed in a way that does not prejudice the NEPA process. In particular, interim decisions must be of a nature that preserves options rather than forecloses them.

The IRG recommends the following key characteristics of a near-term interim strategic planning base for HLW disposal:

- Near-term program activities should be predicated on the tentative assumption made for interim planning purposes that the first disposal facilities for HLW will be mined repositories. Several geological environments possessing a wide variety of emplacement media will be examined. Once the NEPA process has been completed, program activities can be tailored accordingly.

- Near-term R&D site characterization programs should be designed so that, at the earliest date feasible, sites selected for location of a repository can be chosen from among a set with a variety of potential host rock and geohydrological characteristics. To accomplish this, R&D on several potential emplacement media and site characterization work on a variety of geologic environments should be promptly increased.

- With respect to R&D on technical options other than mined repositories, the nearer term approaches (i.e., deep ocean sediments and very deep holes) should be given funding support so that they may be adequately evaluated as potential competitors; funding for rock melting, space disposal, and transmutation would allow some feasibility and design work to proceed.

- A number of potential sites in a variety of geologic environments should be identified and early action should be taken to reserve the option to use them if needed at an appropriate future time. Near-term actions should create the option to have at least two (and possibly three) repositories become operational within this century, ideally in different regions of the country.

- Initial emplacement of waste in at least the first repository should be planned to proceed on a technically conservative basis and permit retrievability of the wastes for some initial period of time.

As part of this near-term interim strategic planning basis for HLW disposal, the IRG also recommends that:

- Work should proceed promptly to permit siting of one or more intermediate scale facilities (ISF's) 1/ in different emplacement media and geologic environments. All ISF's should be licensed since these elements will be an important step in the ultimate location and construction of repositories to acquire institutional experience and to protect public health and safety.

1/ In this Report, the term intermediate scale facility applies to a facility in which some hundreds, perhaps as many as 1000 spent fuel assemblies or waste canisters would be emplaced. In this case, waste would be emplaced with the possibility of removing it, if necessary, but without the expectation to do so. "R&D facility" is used to mean a test with heaters or with small quantities where no more than some tens of spent fuel waste assemblies or waste canisters would be emplaced for a limited test period and then removed.

The earliest possible date at which such a licensed ISF could be in operation is estimated to be late 1986.

The IRG particularly welcomes public comment on the use of intermediate scale facilities in the transition from R&D to full-scale operational disposal facilities.

The IRG also recommends constructing waste disposal facilities sited on a regional basis insofar as technical considerations permit. Regional siting would reduce the transportation requirements and attendant risks, provide redundancy that would hedge against the possibility of operational difficulties causing unexpected repository shut down and, could assist in repository siting by distributing the burden across more than one location. In applying this approach, there is the risk that organizational and political commitments might develop to particular regions or locations to such an extent that less than full attention would be given to safety, environmental, and security considerations.

The IRG particularly welcomes public comment on the adoption of this criterion to siting waste disposal facilities.

The IRG has considered, but not formulated an opinion at this stage of its review, whether the interim strategic planning basis for the first repository should presume, pending decisions taken through the NEPA process, either:

- o that near-term programs would plan for an early choice of a first repository site from a set of potential sites covering a limited range of geologic environments; or
- o that near-term programs would assume that the choice of the first repository site will await the availability of a set of potential sites covering a broader range of geologic environments.

In the latter case, the choice of site could not be made before 1984 and construction of the first repository could be completed at the earliest by 1992; prudent planning suggests anticipating initial operation during the period 1992 to 1995. In the former case, a choice might be made from among sites that rely on salt as the emplacement media as early as 1980 since generic understanding of engineering features of a salt repository are most advanced. Construction of the first repository could be completed as early as 1988; prudent planning suggests anticipating initial operation during the period 1988 to 1992.

Siting and construction of a repository at an early date could indicate progress in safe management of wastes and increase knowledge more rapidly. This approach would, however, involve higher near-term costs and run increased risk of both technical and institutional failure which could be detrimental to the overall program. Moreover, by focusing the program at this point on near-term options (principally salt repositories), this approach risks prejudicing the NEPA review by tending to foreclose options prematurely. Since there are balancing considerations involved, further evaluation is required before a decision can be made on this element of the interim strategic planning basis.

Public comment on this question will be particularly welcomed.

In any event, the Federal government should maintain a technically conservative approach in pursuing the development of mined repositories for high-level and TRU waste disposal. For example, the repository could be loaded initially with cooler waste or at a lower heat generation per acre than design studies suggest is necessary. The waste-emplacement rate could be lower during early operation to permit observation of a small number of waste filled canisters. And the repository would be designed, constructed, and operated so the emplacement waste could be retrieved during an initial period of operation. The ability to retrieve emplaced waste acts as a hedge against unforeseen problems that could occur relatively soon after the wastes are emplaced and that might jeopardize the safe operation of the repository.

Defense High-Level Waste

With respect to the interim storage and processing of defense HLW, the IRG recommends the DOE accelerate its R&D activities oriented toward improving immobilization and waste forms and review its current immobilization programs in the light of the latest views of the scientific and technical community. Since final processing of defense waste has been deferred for three decades, the IRG also recommends that remedial action, including immobilization of the waste, should begin as soon as practicable.

Transuranic Waste

With respect to TRU waste disposal, the IRG recommends adopting, as an interim strategic planning basis pending NEPA review, the concept of proceeding with an early TRU repository if an opportunity exists to do so. Whether or not this concept can be implemented in fact will depend on matters such as determination of site availability and suitability, NEPA evaluations, regulatory decisions, and decisions whether to exhume or to leave in place existing TRU wastes. These matters will occur in the future and cannot now be predetermined.

The implementation of this recommendation could conceivably be by means of the Waste Isolation Pilot Plant (WIPP) program, now underway at the Department of Energy. WIPP is a conceptual facility for which detailed engineering specifications have yet to be formulated. It is currently intended for ultimate geologic disposal of TRU wastes from the defense program and as a facility in which to perform R&D in salt with other waste material.

The DOE has for some time been examining a site near Carlsbad, New Mexico as a possible location for the WIPP facility. The site evaluation report and the Environmental Impact Statement relevant to this site have not yet been completed, but publication for public review and comment is expected shortly. In the absence of these documents, neither the DOE nor the IRG are yet in a position to form a judgement about the adequacy of this site. This judgement will be made through the NEPA process at a later date.

Uranium Mill Tailings

The policy approach for handling of uranium mill tailings, which is in progress, and which is endorsed by the IRG, consists of:

- o Passage of legislation, now before Congress, that will authorize EPA to issue standards and criteria for disposal of mill tailings, establish NRC licensing authority over active sites, and authorize DOE to take remedial action at inactive sites.

- o Completion of a Generic Environmental Impact Statement (GEIS) on uranium milling by NRC.

- o Development of standards, criteria, and regulations by NRC and EPA on acceptable levels of radon emissions, siting (to reduce the possibility of human exposure to tailings and to provide for long-term isolation), impacts on groundwater, and methods of ultimate disposal.

- o Determination and development of improved means of disposing of or stablizing mill tailings over the long term. Only recently have innovative methods been initiated. Time is needed to evaluate these methods as well as to explore additional methods of disposal and stabilization.

- o Significant increases in DOE's R&D program on mill tailings disposal. This is already a major research area at EPA where the results are needed in the preparation of standards. In addition, EPA plans to conduct field studies at mill facilities to compare new methods with old.

- o Continuation of the present NRC practice of requiring licensees to reclaim the tailings in a way such that the radioactivity is reduced to near natural background levels and the possibility of human disruption and misuse is minimized.

INSTITUTIONAL ISSUES

The resolution of institutional issues required to permit the orderly development and effective implementation of a nuclear waste management program is equally important as the resolution of outstanding technical issues and problems. The solution of institutional problems involves difficult implementation issues and will require major Federal action.

The benefits of nuclear energy are enjoyed, to a greater or lesser degree, by all of society. An increasing number of States are relying on nuclear power for electricity generation. Research, industrial, and medially-related activities, and those associated with the defense program, are designed to benefit the citizens in every State in the nation. The problems associated with the disposal of wastes generated in the process must therefore be addressed by society as a whole.

Each State has responsibilities for protecting its population, in terms of health and safety, against the potential hazards of such waste; and many States have already demonstrated the ability to manage effectively nuclear material regulatory programs. Furthermore, the States are calling for an increased role in the planning and development of a national nuclear waste management policy and program. Consequently, a genuine and effective partnership of "cooperative Federalism" should be initiated between the States and the Federal government.

To nurture a cooperative approach, the IRG considered a variety of institutional mechanisms including (1) specially created State Advisory Committees; (2) specially created regional advisory committees; (3) Federal-State task forces; and (4) separate liaisons with each different type of national organization of State and/or local officials.

Executive Planning Council

The IRG recommends that the President establish, by Executive Order, an Executive Planning Council. The Executive Planning Council would consist of selected governors 2/, selected Indian nation representatives, officials of national organizations of State and local governments 3/, and representatives of DOE and other Federal agencies.

2/ These governors should represent a complete spectrum of States including those that have expressed opposition to siting facilities within their boundaries, and States with more neutral views, as well as States with major nuclear installations.

3/ Example organizations are: the National Conference of State Legislatures, United States Conference of Mayors, National League of Cities, National Association of Counties, National Association of Regional Councils, and Council of Energy Resource Tribes.

The purpose of the Executive Planning Council is to:

- o Identify joint Federal/State planning activities in nuclear waste management.
- o Identify and agree on the appropriate existing or new mechanisms and timetables for carrying out such joint activities.
- o Develop mutually acceptable criteria for evaluating proposed nuclear waste management activities (from R&D and geological characterization through the possible siting of disposal facilities).
- o Develop regional waste disposal facility siting plans and support State "consultation and concurrence" activities.
- o Support design, preparation, and evaluation of environmental impact statements covering waste management activities.
- o Develop a mechanism for planning which will effectively represent all interests and concerns not only at the State level (executive and legislative branch) but also at the local level.
- o Identify other Federal/State actions needed to maximize the likelihood of success of the overall program.

Siting

There has been growing concern over State acceptance of locating a Federally-proposed nuclear repository site within that State. Some members of the public have urged the IRG to rely exclusively on Federal supremacy for waste repository sites. Others have proposed that a State should have the authority to veto Federally-proposed nuclear waste repository sites within that State. Still others, including the National Governors' Association and the National Conference of State Legislatures, have proposed a Federal/State process of "cooperative Federalism" or "consultation and concurrence." Under this approach, the States would continue the involvement begun in the planning phase by reviewing early site characterizations and potential sites of disposal facilities. The State would be in agreement with each step in the process before the next activity was begun.

The IRG does not believe that a policy preference for either exclusive Federal supremacy or State veto is appropriate at this time. The IRG does believe, however, and recommends that the "consultation and concurrence" approach should be adopted.

NEPA Review

Successful planning and development of disposal facilities require State involvement in both the NEPA and the regulatory process:

- o States should participate in the development and review of NRC and EPA regulations and standards that affect siting, public health and safety, environmental impacts, and financial responsibilities.
- o States should participate to a greater extent in NRC licensing procedures.
- o States should receive technical and financial help from the Federal Government to help ensure the regulatory process is carried out fully when State licensing is involved.

Public Participation

In addition to their interaction with State and local government entitites, the Federal agencies responsible for developing a nuclear waste management plan and program need to interact with the public. The IRG's own experience with public participation and the recommendations of many citizens appearing before the IRG indicate the urgent need for sustained, effective efforts to inform the public and to provide opportunities for discussion between the public and the government.

To generate a spirit of openness on the part of the government and of full participation on the part of the public, IRG recommends that, at a minimum, the President encourage, direct, and/or coordinate a program to:

- o Routinely update the status of scientific and technical knowledge on nuclear waste management and provide this information to the public at large in understandable terms.
- o Increase interaction and discussions between Federal program managers and nationally or locally based institutions and organizations desiring such interaction and discussion.
- o Support private sector efforts to generate a greater degree of social and technical understanding and agreement on nuclear waste management issues.

ISSUES SPECIFIC TO WASTE TYPES

A number of institutional issues pertaining to nuclear waste management relate to specific types of nuclear waste (spent fuel and LLW) and to specific crosscutting activities (transportation).

Spent Fuel

The IRG recommends that the implementation of the President's Spent Fuel Policy including the offer to accept limited amounts of foreign spent fuel when this would further U.S. nonproliferation policy be pursued vigorously and appropriate legislation be submitted to Congress. The costs of Away-From-Reactor (AFR) storage for the domestic utility industry should be paid for by that industry and borne by the rate payer.

Low-Level Waste

With respect to LLW shallow land burial disposal sites, national planning that assures an adequate number of sites, regionally located and available when needed, is not occurring. The IRG recommends that DOE assume responsibility for developing and coordinating the needed national plan for LLW with active participation and advice from other concerned Federal agencies and input from the States, general public, and industry.

The IRG further recommends that States be provided the option to retain management control of existing commercial LLW sites or to transfer such control to the Federal Government. Future sites could be developed either by the individual States or by the Federal Government but such actions should be taken within the agreed-upon framework of an overall LLW siting plan, developed through a joint Federal/State partnership.

Transportation

Transportation is an important element of the overall waste management system. Attention to safety is equally as important in highway, barge, and rail traffic as in every other aspect of the system.

State and local officials have expressed concern regarding the safety of nuclear waste transportation through, or near, populated areas. The IRG views the recent initiation of a public rulemaking proceeding by DOT as a very important step towards resolution of this issue. DOT should proceed expeditiously to examine the desirability of Federally prescribed routing requirements for barge, rail, and highway shipment of radioactive wastes, as well as the question of to what degree local restrictions are appropriate.

Further specific IRG findings and recommendations on transportation matters are as follows:

- o DOE in conjunction with NRC, DOT, and EPA, and with input from the nuclear and transportation industry, should identify program needs for testing and evaluating the performance of current and future generation packaging systems during accident conditions for all forms of transportation including barge, rail, and highway.

- o DOT, with assistance from other agencies and industry, should develop a data bank on shipment statistics and accident experience to be operational by 1982.

- o Assurance should be provided for early state participation in the highway, rail, and barge routing planning process by including consideration of transportation issues in the scope of activity in the Executive Planning Council.

- o Federal assistance in the development of capability for handling emergencies should be expanded, involving all levels of government.

IMPLEMENTATION RECOMMENDATIONS

Three approaches to managing a nuclear waste disposal program are:

- o Using ad hoc or formal interagency committees to coordinate independent programs;

- o Assigning primary responsibility for planning and managing nonregulatory programs and for interfacing with regulatory programs to a single agency; or

- o Assigning primary responsiblity for planning and managing nonregualtory aspects of the program to a newly created independent Government authority.

The first approach would be cumbersome as an ongoing management method and would lack a programmatic focal point. The third approach would delay actions that should be taken immediately while the structure was defined and the authority was organized. The IRG recommends that the second approach be adopted and that DOE be given the primary responsibility for developing and integrating the overall planning for the nonregulatory program and for interfacing with the regulatory programs.

One major task of the DOE would be to update the comprehensive nuclear waste management plan within the context of the national energy policy. These updates would be delivered simultaneously with the National

Energy Plan beginning in 1981, but would receive independent public review and comment. One component of this activity would involve updating the documents prepared by the IRG setting forth the status of knowledge relevant to various technological options for disposal of HLW and TRU wastes.

Furthermore, DOE must provide the capability to implement the recommendations set forth in this Report. These actions are:

- o Incorporate the outputs of the Executive Planning Council into the overall national planning.
- o Interact with the public on nuclear waste management matters.
- o Develop detailed plans for implementation of the NEPA process, accomplishment of R&D programs, and for the D&D of surplus Federal facilities.

A final important implementation matter relates to the development of various criteria and standards for nuclear waste management by DOE, EPA, and NRC. EPA's standards on acceptable levels of radioactivity in the environment are general rather than site-specific or method-specific. EPA will provide:

- o General criteria, which will be applicable to all waste management options. These proposed criteria will be issued in draft form for public comment in Nobember 1978, and will be reviewed by the various agencies involved.
- o Numerical standards for each type of waste. EPA is developing generally applicable environmental standards for the disposal of high-level waste and discarded spent fuel. These standards will be issued in draft form for public comment in December 1978. However, standards for the other types of waste are not planned to be available until 1983 to 1985.

The IRG recommends that the EPA schedule for standard setting activities be accelerated. The regulatory agencies have proposed such an accelerated schedule and it is detailed in the full Report. The IRG welcomes public comment on the proposed accelerated schedule, particularly with regard to the timing and priorities reflected in the schedule.

Further, the IRG recommends that EPA in consultation with DOE and NRC should prepare a position paper by mid-1979 that sets forth written guidance in advance of issuance of EPA standards, indicating EPA's final proposed approach in developing specific standards for various classes of waste. DOE should take the lead in devising the actions needed to apply the new standards to previously disposed of waste (including waste produced from decontaminating and decommissioning old facilities). This task should be undertaken as a major part of the ongoing interagency waste management planning effort headed by DOE.

LEGISLATIVE REQUIREMENTS

Legislation will be needed, based on the tentative findings and recommendations of this draft Report, for the following key areas and activities:

- Extension of NRC licensing authority to cover new DOE facilities which would at a minimum include:
  - interim storage and possible disposal of spent fuel from commercial reactors and
  - ultimate disposal of TRU and nondefense LLW.
- Establishment of the Executive Planning Council.
- Implementatio. of the President's Spent Fuel Policy.
- Support of Federal ownership of commercial LLW burial sites.

DRAFT WORK PLANS

The IRG has developed draft work plans to address its procedural, technical, institutional, and managerial issues and recommendations. These work plans, presented in detail in the full Report, contain the major decision points which are highlighted in the summary which follows.

The work plans are intended to provide perspective with regard to the timing of major events. They are based on the assumptions that programs and events will proceed in conformance with current expectations. Dates and program targets and schedules are idealized. There are varying degrees of uncertainty associated with the actual likelihood of specific events. In order to provide a complete picture, the outcome of certain future decisions and the duration of certain future activities must be assumed. Therefore, the following work plan schedules show the earliest possible date to complete an event. Estimates of uncertainty are shown in some cases to indicate the possible range of slippage associated with a single event and/or the total project.

SUMMARY WORK PLAN

Waste Type	1979	Responsible Agency
All	Submission of legislation for establishment of an Executive Planning Council	DOE
Spent Fuel	Submission of legislation to implement spent fuel offer	DOE
TRU	Submission of legislation to establish NRC licensing authority for TRU disposal; and submission of license application to NRC	DOE
LLW	Submission of legislation authorizing DOE to accept responsibility for low-level waste burial sites voluntarily transferred from States to DOE	DOE
Uranium Mill Tailings	Enactment of pending legislation for both active and abandoned mills	DOE/NRC
Uranium Mill Tailings	Publication of final Generic Environmental Impact Statement and updated regulations on uranium mill tailings	NRC
All	Promulgation of environmental protection criteria for radioactive waste and the Waste Standards Rationale document	EPA
HLW	Promulgation of high-level waste numerical standard	EPA
HLW	Publication of final Generic Environmental Impact Statement for Commercial Waste Management	DOE
TRU, LLW, HLW	Promulgation of waste classification system study as a basis for NRC standards and criteria establishment	NRC
HLW	Proposed procedures and technical requirements for licensing geologic repositories	NRC

Waste Type		Responsible Agency
	1980-1982	
HLW	Selection of initial HLW repository site and submission of license application to NRC (depends on approach 1/ selected)	DOE
	1982-1984	
Spent Fuel	Issuance of operating license for AFR (depends on choice between existing and new locations)	NRC
	1984-1986	
HLW	Selection of initial HLW repository site and submission of license application to NRC (depends on approach 2/ selected)	DOE
	1986	
TRU	Initial operation of TRU disposal facility	DOE/NRC
	1988-1992	
HLW	Initial operation of first high-level waste disposal facility (depends on approach 1/ selected)	DOE/NRC
	1992-1995	
HLW	Initial operation of first high-level waste disposal facility (depends on approach 2/ selected)	DOE/NRC

Key

DOE Department of Energy
EPA Environmental Protection Agency
HLW High-Level Waste
LLW Low-Level Waste
NRC Nuclear Regulatory Commission
TRU Transuranic Waste

1/ Based on early salt repository

2/ Based on selection from broader set of geologic environments

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