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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF	)	
	)	
PROPOSED RULEMAKING ON	)	
THE STORAGE OF DISPOSAL	)	PR-50,51
OF NUCLEAR WASTE	)	(44FR61372)
	)	
(Waste Confidence Rulemaking)	)	

STATEMENT OF POSITION OF THE NATURAL RESOURCES DEFENSE COUNCIL

7 July 1980

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I. Introduction and Summary

The purpose of the Nuclear Regulatory Commission's "waste confidence" proceedings is to assess the degree of assurance now available that the radioactive wastes produced by the nation's nuclear power plants can and will be safely disposed of prior to the expiration of current faculity licenses, or safely stored at reactor sites until off-site disposal is available.

The NRC has been directed to make this assessment 35 years into the nuclear age. It has been ordered by the Court of Appeals for the District of Columbia Circuit to determine whether the American public now and in the future can and will be adequately protected from the hazards created by the ever increasing quantities of radioactive wastes in the nation's nuclear plants.[1] The NRC must find that its confidence that a solution will one day be found has a basis in fact.

The Natural Resources Defense Council will demonstrate in this statement that there exists no basis for assurance that radioactive wastes produced by nuclear power plants can and will be disposed of safely before the expiration of current nuclear plant licenses, or that spent nuclear fuel can and will be stored safely on-site until off-site disposal is available.

1. There is no standard by which to judge the DOE program which will provide the NRC confidence that wastes will be dis-

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1/ State of Minnesota v. NRC, 602 F.2d 412 (D.D.Cir. 1978)

posed of safely. Since no waste disposal plan is currently operational the NRC lacks a factual basis for determining that geologic repositories can and will operate without endangering the public health and safety throughout the entire period during which the wastes will remain dangerous. Thus the standard applicable to the issuance of an operating license for a nuclear power plant cannot be met by the DOE program. Nor can the NRC find reasonable assurance that DOE has described and will conduct a program designed to resolve all outstanding safety questions and result in the availability, implementation and utilization of an acceptable waste disposal system. Thus, the DOE program does not even meet a construction permit standard.

2. The historical record of the federal government's waste disposal program provides no basis for confidence that spent nuclear fuel will be managed safely. It is a history of "unbroken failure to produce an acceptable method of waste disposal",[2/] a history of fits and starts and major changes in direction and focus from geologic disposal to retrievable surface storage and back. Along the way the government has adopted and then been forced to abandon disposal sites, media and technologies. It has aroused the ire of local politicians and the opposition of the public. It has failed to understand that the problems are not only technical, but institutional and

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2/ G. Speth, "Mandate for the Future: Nuclear Wastes and The Public Trust," AAS, Houston, Texas, January 5, 1979, p. 7.

social as well. Finally, it has underestimated the complexity and difficulty of the task. The history of the government's waste disposal effort shows that little has been learned in the past 20 years. Certainly the history offers the NRC no assurance that the future effort will be successful.

3. There is no basis for confidence that the DOE program as described in the Statement of Position will result in the availability, implementation and utilization of a safe waste disposal program within the time required.

a. DOE has not developed a plan which will meet even the NRC's draft performance criteria for geologic repositories. In numerous instances, DOE's program objectives are in conflict with the NRC's criteria. Even when they are not, there is no evidence that the NRC criteria will be met by the DOE program.

b. There is no evidence that any of the specific alternative disposal schemes, media and sites presently being pursued can and will be used for safe waste disposal. Of the ten alternative disposal methods set forth in the DOE Statement of Position, only geologic disposal is a viable candidate. Others lag far behind in development or are so theoretical as to be beyond the realm of present possibility.

With respect to geologic disposal, DOE's program has failed to identify an acceptable host rock which meets the NRC's technical criteria. The NRC criteria appear to rule out the use of salt and basalt, and possibly eliminate argillite, granite, alluvium and tuff as well.

c. DOE's research and development program provides no basis for NRC confidence that the effort necessary to produce a safe and reliable waste disposal system will be conducted.

DOE's research and development program is not designed to provide the comprehensive research effort required to resolve the outstanding problems with its waste disposal plan. Basic research tasks have not been defined and carried out in a systematic way. For example, in situ testing and the development of the technology for successful borehole and shaft sealing lag for behind other, less important research efforts. The program does not adequately address the uncertainties associated with the selection of a suitable host rock. Nor will it lead to the choice of an adequate waste form. Site work has been restricted mostly to federal reservations in order to avoid public conflict. In addition to the technical deficiencies, the program ignores whole sets of important social, economic and political factors, and it includes no clearly defined organizational plan for implementation.

d. DOE has not adequately identified or addressed the social, political and economic issues involved in the implementation of its waste disposal program. Its emphasis continues to be on the development of the technical features of the waste disposal system, although the resolution of institutional issues is of equal importance. Indeed, failure to properly resolve the social obstacles to implementation may doom an otherwise acceptable program.

Among the key social and political obstacles to the implementation of DOE's program are public opposition and lack of trust, as evidenced by the efforts of states and localities to prevent waste transportation and disposal in local jurisdictions, questions of equity in the allocation of the risks of waste disposal, and the repeated changes and redirections in regulatory policy made by the various federal agencies with responsibility for waste disposal and the Congress.

A second aspect of the problem comes in scaling up the system to cope with the wastes produced by an expanding nuclear industry. The entire focus of the DOE program is on the location, construction and operation of the first repository. However, the NRC must also determine whether there is any basis for confidence that DOE can and will design, construct, and operate the additional disposal facilities which will be required immediately after the first such repository has been built. The DOE Statement simply does not analyze the organizational or institutional problems which are inherent in the inevitable next phase of waste disposal.

The most basic of these problems is that the waste disposal system must be essentially error-free from the outset. As has been recognized by several experts, the incremental approach to perfect performance is explicitly not an option for the waste management program. There is no basis for confidence that the DOE program can be scaled up effectively.

Finally, there is no basis for confidence that wastes can

be managed without hazard to the public for the entire period in which they will remain dangerous. The DOE program fails to even address the issue, much less offer a plan for institutional and social arrangements which can be successful in achieving this goal.

4. All in all the DOE's program is highly likely to result in an unsafe waste disposal program. One reason for this is DOE's overriding concern for preserving the nuclear option which has led DOE to attach the problem in a haphazard and backward manner. Another reason is the fact that DOE is receiving conflicting signals about the objectives of its efforts. There is significant pressure on the agency to push for reprocessing, plutonium recycle and the breeder reactor. These signals are producing a less than enthusiastic effort on behalf of spent fuel disposal.

5. Finally, there is no basis for confidence now available that radioactive waste can be safely stored on site past the expiration of current nuclear plant licenses. At least two fundamental problems with on-site storage remain unresolved. First, on-site storage as contemplated by DOE will require active management, and consequently is vulnerable to the hazards and uncertainties afflicting any program which depends upon human management. These include accidental or deliberate mismanagement, abandonment of facilities , intentional sabotage by outside disruptive forces and large scale social or political disintegration.

Second, there is no basis for confidence that on-site storage of spent fuel can be safely accomplished for the time periods required. There is no experience with water storage of spent fuel beyond the short term, a fact which led the Windscale Inquiry in Great Britain to conclude that it would not be prudent to store spent fuel for long periods.

6. In sum, this statement will demonstrate that there is no basis for confidence that a safe and implementable waste disposal program will be available before the expiration of current nuclear plant licenses.

II. The NRC Must Have Confidence that Wastes Can and Will Be Disposed of Safely, as Required by the Atomic Energy Act and the Commission's Regulations, Before the Expiration of Current Nuclear Power Plant Licenses.

A. The NRC Must Have Confidence That the Wastes Produced By Nuclear Power Reactors Can and Will Be Disposed of Safely.

The question at issue in this proceeding is whether there is a basis for confidence that the wastes produced by commercial nuclear power reactors can and will be disposed of safely.[3] To resolve this question affirmatively will require the NRC to reach conclusions about the DOE waste disposal program which go beyond the finding of DOE that:

> The analyses performed to date give no indication that a mined geologic disposal system, designed and constructed according to the requirements described in this Statement, cannot isolate radioactive waste safely. [4]

The simple question of whether wastes "can" be disposed of safely is not at issue. No informed commentator has claimed that it is now and will continue to be impossible to isolate or contain high-level radioactive wastes. No laws of physics must be violated to produce a waste disposal program. Theoretically therefore, waste containment and isolation are feasible. The demand placed on DOE and the NRC is not to show that isolation can be achieved, but to show that it both can and will be achieved, within the requisite time period.

3/ Letter concerning "Waste Confidence" proceeding from Gus Speth, Chairman of the Council on Environmental Quality, to Nuclear Regulatory Commissioner John Ahearne, April 15, 1980.

4/ DOE Statement of Position, p. II-242.

The purpose of the waste confidence proceedings is not to examine the theoretical possibilities for a future solution to the problems of radioactive waste disposal. On the contrary, as the President stressed in his Congressional Message of February 12, 1980, the NRC must reach a judgment in the proceedings on whether it has confidence that wastes produced by nuclear power reactors can and will be disposed of safely.

> [I]t is important that the NRC reassess and decide the question of whether safe, ultimate disposal of nuclear wastes both can and will be provided. The NRC should not limit its inquiry to the much less important question of whether safe temporary (on or off-site) storage can be provided. Nor should the NRC focus simply on the question of whether it is technically possible to provide safe, ultimate disposal; it is important for the public, the Congress, and the Executive Branch to have the NRC's assessment of whether safe ultimate disposal will be provided as well as its assessment of whether it can be provided. 5/

B. The NRC Must Have Confidence That Presently Existing Spent Fuel Will Be Disposed of Safely Before the Expiration of Current Nuclear Power Plant Licenses.

The DOE Statement of Position states that DOE has adopted as its target date for the implementation of a waste disposal program the years between 1997 and 2006.6/ DOE's choice of dates obviously reflects the decision of the Court of Appeals for the District of Columbia Circuit in State of Minnesota v. NRC, 602 F.2d 412 (D.C. Cir., 1979). This case held that the

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5/ Letter from Gus Speth to John Ahearne, op cit.

6/ DOE Statement of Position, p. I-4.

NRC must determine that it has a basis for confidence in the availability of an off-site waste disposal solution before the expiration of the operating licenses for the Vermont Yankee and Prairie Island nuclear plants in the year 2007.

The NRC decided to make this determination in the context of a generic review of the waste disposal issue. By so doing, it expanded the scope of the proceedings to include disposal of wastes from all nuclear plants. As the notice of proposed rulemaking states:

> The United States Nuclear Regulatory Commission is conducting a generic proceeding to reassess its degree of confidence that radioactive wastes produced by nuclear facilities will be safely disposed of, to determine when any such disposal will be available, and whether such wastes can be safely stored until they are safely disposed of. 44 Fed. Reg. 61373 (emphasis supplied).

This approach was specifically approved by the Court of Appeals.

> Where factual issues do not involve particularized situations, an agency may proceed by a comprehensive resolution of the questions rather than relitigating the question in each proceeding in which it is raised. . . [W]e think it clear that the central issue posed by petitioners -- the feasibility of interim or ultimate nuclear waste disposal solutions -- is one essentially common to all nuclear facilities. 602 F.2d ___, 13 ERC 1187.

Because the purpose of the waste confidence review is not simply to determine that spent fuel will be off the site of the Vermont Yankee and Prairie Island nuclear plants by the expiration of their licenses, reliance on the year 2006, or even 1997, as the target date for the waste disposal program is unacceptable.

The date used by the Court of Appeals relates only to the particular facts of the controversy before it in State of Minnesota, supra. It has nothing to do with the time when off-site waste disposal facilities are needed. Such facilities have been needed since the very first nuclear power plant was licensed under the assumption of short-term on-site storage followed by off-site shipment to a disposal facility. At the very least, waste disposal facilities are needed now. The at-reactor storage problem is reaching the critical stage, and plants such as Indian Point I have been shut down for years with no place to send spent fuel. In addition, the clean-up efforts at Three Mile Island will be hampered by the lack of a facility to receive spent fuel removed from the plant.

Pinning the waste disposal effort to the year 2006 allows the federal government 26 more years in which to dawdle with a program which should now be in place. It also makes it virtually impossible to assess concretely whether a safe, reliable system will, in fact, be available and ready for use in a timely manner, since the analysis must depend on speculation and projection.

2006 is not a magic date for purposes of DOE's technical effort. There is nothing in the Statement of Position to indicate that it is a critical year for program development, or indeed has anything to do with the technical aspects of the waste disposal effort. Rather, it offers a convenient excuse for an additional quarter of a century of delay in resolving a central issue in the use of nuclear technology.

Nuclear power plant licenses will expire before 1997. Three Mile Island, Indian [illegible]t 1, and other plants must be decommissioned now and their wastes moved off-site to a disposal facility. The mandate for the NRC in the waste confidence proceedings is to determine whether it has reasonable assurance that DOE can and will develop and implement a safe, reliable, and publicly accepted program at least before current licenses expire and on-site storage becomes permanent by default.

C. The NRC Must Have Confidence That the Standards for Protecting the Public Health and Safety Imposed by the Atomic Energy Act and the Commission's Regulations Will Be Met by the DOE Program.

The requirement that the NRC find that the radioactive wastes produced by nuclear plants can and will be disposed of safely is imposed by provisions of the Atomic Energy Act, 42 U.S.C. 2011, 2133(d), and the Commission's regulations, 10 C.F.R. 50.57(a), (a)(6), and 50.91. These sections direct that licenses and license amendments for nuclear power plants be issued only after a finding that "there is reasonable assurance that the activities authorized by the license can be

conducted without endangering the health and safety of the public" and that "the issuance of the license will not be inimical to the health and safety of the public." Such a finding must rest upon the consideration of evidence about the activities to be licensed and their impacts which has been made on the record of the adjudicatory proceedings established to rule on the matter. In the Matter of Public Service Company of New Hampshire (Seabrook Station, Units 1 and 2), ALAB-422, 6 NRC 33, 41, July 26, 1977.

"Activities authorized" by the NRC include the generation of nuclear waste. This was explicitly recognized by the Court of Appeals for the District of Columbia Circuit in NRDC v. NRC, 547 F.2d 633 (1976), and affirmed by the Supreme Court in Vermont Yankee Nuclear Power Corp. v. NRDC, ___ U.S. ___, 55 L. Ed. 2d 460 (1978). The Supreme Court stated:

> As the Court of Appeals recognized, the environmental impact of the radioactive wastes produced by a nuclear power plant is analytically indistinguishable from the environmental effects of "the stack gases produced by a coal-burning power plants." 178 U.S. App. D.C. at 34, 547 F.2d at 638.

In NRDC v. NRC, supra, the Court of Appeals determined that the impacts of the wastes generated by a nuclear power plant are an integral part of the plant's operation and cannot be ignored simply because the NRC and the nuclear industry hopes and intends at some time in the future to dispose of the wastes away from the site of an individual reactor. A finding that a nuclear plant will operate without endangering the public

health and safety must include a determination that the wastes which it produces will be disposed of safely. The Court stated:

> The real question . . . is whether the environmental effects of the wastes produced by a nuclear reactor may be ignored in deciding whether to build it because they will later be considered when a plant is proposed to deal with them. 547 F.2d at 638.

The question was answered in the negative.

State of Minnesota v. NRDC, supra, in no way changed the earlier conclusion of the Court of Appeals and the Supreme Court. On the contrary, the Court affirmed the Vermont Yankee decision that the finding of safe operation required for licensing a nuclear plant includes consideration of the effects of waste disposal. The Minnesota Court concluded that the issuance of a license or amendment must be based on a record which demonstrates assurance either than spent fuel will leave the site prior to the expiration of the operating license of the nuclear plant in question, or that safe indefinite storage will be accomplished on-site.

D. The DOE Program Does Not Fulfill Any of the NRC's Prerequisites for Confidence.

1. The DOE Program Does Not Meet an "Operating License" Standard.

The courts have recognized the linkage between the safe operation of nuclear power plants and the disposal of the wastes produced by that operation. This linkage demonstrates that an operational waste disposal program ought to have been in place when the first nuclear plant was licensed. At the very least, the linkage requires the NRC to have the same degree of confidence in the safety of waste disposal as it does in the safe operation of nuclear plants. In other words, the NRC must apply to the DOE waste disposal program the kind of standard it applies to requests for operating licenses for nuclear power plants.

10 C.F.R. 50.57 requires the Commission to find, prior to issuance of an operating license for a nuclear power plant, that the plant is essentially complete and that it can and will operate without endangering the public health and safety.

Using an "operating license" standard, there is no assurance that an off-site disposal solution will be in place before the expiration of current facility licenses. No geologic repository has been licensed or constructed. Indeed, none has been designed. An appropriate host medium has not been chosen.

NRC criteria for site selection have not been established. Its draft technical criteria for repository performance conflict with those of DOE and cannot be met by the DOE program. No potential repository site has been evaluated against the draft criteria. Sites chosen for research and development by DOE were selected largely on the basis of federal ownership rather than suitability for location of a repository. Basic research questions remain unanswered, and in numerous areas fundamental work required to define and analyze the technical problems inherent in waste disposal have just begun.

Despite the passage of 35 years into the nuclear age, and at least 20 years of concentrated research and development efforts on waste disposal, the industry and the government have not advanced beyond the assumption that a method for the disposal of the radioactive wastes generated by nuclear power plants will someday be found. This assumption has been used as the basis for continued licensing and operation of nuclear facilities although the efforts to develop the actual disposal method have been plagued with problems and changes in policy and direction.

2. The DOE Program Does Not Meet a "Construction Permit" Standard.

The current predicament of the nuclear industry may make it impossible for the Commission to judge DOE's program by an operating license standard. Spent fuel clogs the nation's reactor storage pools and the limited space available in off-site storage facilities such as Morris and West Valley. Additional wastes are created daily for which a solution must

be found. Even if reactor operation ceased immediately, the efforts of DOE to develop a method for safely disposing of wastes would have to continue. The NRC's obligation in this proceeding would similarly remain.

The NRC may conclude that it can rely on the approach found in its regulations for the granting of construction permits for nuclear power plants. Under these regulations, an applicant which has not supplied initially all of the technical information required to support the issuance of a construction permit must describe, identify, and conduct a research and development program which is "reasonably desigend to resolve outstanding safety questions" prior to the completion of construction (10 C.F.R. 50.35)..

It is clear from the DOE Statement of Position and supporting documents that even under this standard the DOE program fails. DOE does not have in hand all of the data required to design and implement a safe waste disposal solution. In many significant areas, such as borehole and shaft sealing and prevention of corrosion of waste canisters, the technical effort to solve the problems has only just been defined. Nor does DOE have a program which is reasonably designed to resolve the outstanding safety questions, some of which surely have not even been identified. As will be discussed in this statement, the NRC cannot find that the DOE has described and will conduct a program which, in its entirety, provides reasonable assurance that it will result in the availability, implementation

and utilization of a safe and environmentally acceptable waste disposal system.

Because of the dangers involved with waste disposal, confidence in the program must reflect an equal degree of confidence in each of its components. The National Academy of Sciences stated in 1957:

> Unlike the disposal of any other type of waste, the hazard related to radioactive wastes is so great that no element of doubt should be allowed to exist regarding safety.[7]

The Academy later stressed the same point, making even more explicit the degree of assurance which the management of high-level radioactive wastes requires:

> We believe there should be no phenomenon involved in any of the waste disposal schemes that is not completely understood.[8]

In sum, the DOE program, judged by either an "operating license" or a "construction permit" standard, provides the NRC no reasonable assurance of a safe waste disposal program in the time required. The specific areas of deficiency will be discussed in the following sections of this statement.

7/ NAS, 1957, p. 3.

8/ NAS, 1966, p. 20.

III. The Historical Record of the U.S. Nuclear Waste Program Does Not Provide a Basis for Confidence That Spent Nuclear Fuel Will Be Managed Safely.

Since the late 1950s, the Department of Energy (DOE) and its predecessor agencies have proposed to isolate radioactive wastes by burying them underground.[9/] However, after 20 years of research and development on waste disposal, DOE still is unable to demonstrate that geologic disposal can and will isolate radionuclides for the requisite thousands of years necessary to protect the public health and safety. Two fundamental problems have plagued the effort. First, ". . . federal officials . . . [have] failed to understand that they are dealing with problems that [are] not solely or even primarily technical in nature."[10/] Second, the technologists in charge of finding a way to keep wastes out of the biosphere have seriously underestimated the complexity and difficulty of the task. Failure to confront these issues has resulted in a history of delays, missteps, and radical changes of direction for the waste disposal program. This history is instructive because it illustrates how little the federal government has learned in all of its years of involvement with the problem. The same issues confront DOE today as in the 1950s, and the same criticisms can be made of the program outlined in its Statement of Position and in the documents incorporated in it.

9/ National Academy of Sciences, The Disposal of Radioactive Waste on Land, Report of the Committee on Waste Disposal of the Division of Earth Sciences, Publication 519 (1957).

10/ R.G. Hewlett, Chief Historian, U.S. DOE, "Federal Policy for the Disposal of Highly Radioactive Wastes from Commercial Nuclear Power Plants, an Historical Analysis" (March 9, 1978) p. 3.

After the passage of the Atomic Energy Act of 1954, the Atomic Energy Commission (AEC)[11/] and its advisors focused on bedded salt deposits as the most likely geological formations for disposal of commercially produced high-level wastes. Then, in the early 1960s, the AEC de-emphasized the goal of achieving federally regulated, deep geologic waste disposal. Instead, it proposed to delegate responsibility to the nuclear industry and eventually to state governments under a plan that contemplated indefinite storage of reprocessed high-level wastes in liquid form in near-surface storage tanks. The plan called for the repeated transfer of these wastes to new tanks as the old storage tanks wore out.

This program for perpetual tank storage, instituted at a facility near West Valley, New York, was based upon inadequate study. Liquid wastes were placed in the storage tanks at West Valley, although no method had been determined in advance to ensure that the wastes could be safely removed from the tanks

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11/ In 1974, pursuant to Section 104 of the Energy Reorganization Act (ERA), 42 U.S.C. § 5814, the Atomic Energy Commission was abolished and its functions split between the Energy Research and Development Administration (ERDA) and the NRC, 42 U.S.C. §§ 5811 and 5841. ERDA was given responsibility for research and development programs related to nuclear activities. 42 U.S.C. § 5813. The NRC was given licensing responsibility for nuclear activities, including licensing of nuclear reactors, 42 U.S.C. § 5834, and waste disposal facilities, 42 U.S.C. § 5842. Pursuant to Section 202 of the Department of Energy Organization Act, Pub. L. No. 95-91 (1977), ERDA's nuclear waste management development and research functions were transferred to the Department of Energy.

when it came time to transfer them. Even today, no satisfactory removal method has been developed for the wastes at West Valley, and additional special research must now be conducted. The cost of solving the waste disposal problem at West Valley may be more than five hundred million dollars -- more than 15 times the original cost of the facility and more than 100 times the monies set aside by the company to deal with the wastes.

In the late 1960s, the government renewed its effort to develop a deep geologic repository. An abandoned salt mine near Lyons, Kansas, was selected as the ideal location for a pilot facility. Investigations which followed the initial testing of the mine disclosed, however, that water from adjacent mining operations might seep in to the repository and dissolve the salt. Concern also developed about the potential intrusion of water into the mine from the many abandoned wells dotting the area. Residents of Kansas became increasingly opposed to the project, and in early 1972 it was halted, in part because of the strong public sentiment against it. The Chief Historian of DOE in his review of federal waste management policy through 1977 has said of this experience ". . . the AEC learned a classic lesson in American politics: A federal agency disregards at its peril the potential power of state and local officials whose opinions reflect the consensus of their constituency on matters of health and safety."12/

12/ Hewlett, op. cit., p. 18.

In May 1972, the AEC announced its plan to build a so-called "retrievable surface storage facility" or "RSSF" -- an engineered facility constructed near the surface of the earth -- to store the wastes for an indeterminate period of time, while the prolonged search for an acceptable, safe geological site continued. This incremental approach to final waste disposal was judged to be unacceptable by many of the agencies and organizations concerned with the problem. In 1975, the Energy Research and Development Administration (ERDA) withdrew its request for funding for the RSSF, although it was purportedly retained as a back-up system in case other repository plans failed.

In 1976 ERDA once again attempted to locate and construct a geologic repository. A potential site was found in northern Michigan. In June 1977, however, the federal government abandoned the effort after residents of the area voted overwhelmingly to prohibit the siting of a waste repository within their state.

In his review of federal waste management policy through September 1977, the Chief Historian of DOE made an observation which explains much of the AEC's repeated difficulty in its attempts to decide upon and site a waste disposal facility.

> [T]he [Atomic Energy] Commission did nothing to broaden staff capabilities beyond those of the scientists, engineers, and administrators who had been directing various aspects of the waste disposal program since 1947. No effort was made to study economic, political, and social factors that could well determine whether a specific waste disposal system could be installed at a given site. In this sense, the Commission learned little from fifteen years of frustration and

disappointment in attempting to establish an acceptable waste disposal system. 13/

Since 1977, the debate within the scientific community about the ultimate feasibility of safe waste disposal has greatly intensified, and the federal agencies charged with responsibility for the development of a waste disposal system have issued a number of studies which highlight the continuing uncertainties.

In 1977, for example, a report prepared by the Jet Propulsion Laboratory for the President's Office of Science and Technology Policy concluded that ". . . the U.S. program for high-level waste management has significant gaps and inconsistencies."14/

The U.S. Geological Survey (USGS), the most knowledgable federal agency on technical geological matters, emphasized in 1978 the uncertainties involved in assessing the capability of geological formations to isolate radioactive wastes,15/ and its opinions were reinformed by a report of the same year from a special panel of earth scientists to the U.S. Environmental Protection Agency.16/

13/ Id., p. 29.

14/ T. English, et al., An Analysis of the Back End of the Nuclear Fuel Cycle with Emphasis on High-Level Waste Management, Jet Propulsion Laboratory Pub. 77-59, viii (August 12, 1977).

15/ Geologic Disposal of High Level Radioactive Waste - Earth-Science Perspectives, Geological Survey Circular 779 at 3 (1978).

16/ Report of an Ad Hoc Panel of Earth Scientists, the State of Geological Knowledge Regarding Potential Transport of High-Level Radioactive Waste from Deep Continental Repositories, EPA/520/4-78-004, at 32 (June 1978).

Finally, in March 1979, a federal interagency review group prepared a comprehensive report for submission to the President, reviewing the nuclear waste disposal program and recommending changes to improve it. The final report, entitled Report to the President by the Interagency Review Group on Nuclear Waste Management,[17] stated:

> [T]he management of radioactive wastes for the past three decades can be characterized by inadequate integration of waste management R&D [research and development] efforts. . .caused in part by inadequate perceptions of the additional technological and scientific capabilities needed to develop an acceptable disposal program . . . .

The federal government has now begun again the search for a geological formation that might serve as a permanent waste repository. In addition to the unresolved technical problems, serious political and social resistance to the siting of a disposal facility continues to mount throughout the country. Against the backdrop of past mistakes, abandoned programs and growing political opposition, there is substantial question whether the federal government ever will develop and implement a safe method for the permanent disposal of radioactive wastes.

Confidence in DOE's program must be judged in light of its past efforts, for they illustrate the agency's commitment to the task, its organizational ability and its perception of the obstacles to implementation. DOE has made little real progress towards its goal of a safe, readily implemented waste disposal method. The issues facing the agency today are

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17/ TID-29442 (March 1978).

> . . . strikingly similar to those which the federal government ha[s] faced in managing nuclear wastes since 1955. The enduring nature of these wastes suggest[s] that solutions [will] not be found in short-term responses to technical problems or adjustments to political pressures. Rather, ultimate solutions seem likely to lie in a wise and penetrating analysis of the amalgam of economic, political, cultural and technical factors. . . 18/

As the Chairman of the Council on Environmental Quality observed:

> [W]e have inherited a badly flawed federal program that provides a poor basis for getting to the right answer quickly and no basis at all for public confidence. The history of waste management in the U.S. provides ample warning of the risks of having policy formulation colored by past programs and nuclear promotional concerns. It is a history of unbroken failure to produce an acceptable method of waste disposal. [Emphasis added.] 19/

18/ Hewlett, op. cit., p. 1.

19/ G. Speth, "Mandate for the Future: Nuclear Wastes and the Public Trust," AAAS, Houston, Texas, January 5, 1979, p. 7.

IV. DOE Has Not Described or Demonstrated That It Will Conduct a Program Which Will Result in the Availability, Implementation, and Utilization of a Safe Waste Disposal Plan in the Time Period Required.

A. DOE Has Not Developed a Plan Which Will Meet NRC Criteria.

At least three sets of criteria are necessary to evaluate the question of assurance that radioactive waste can be safely disposed of. They are: (1) environmental criteria, (2) site selection criteria, and (c) performance criteria for the repository and disposal facility.

1. Environmental Criteria

The EPA is required to issue appropriate environmental criteria for all fuel cycle activities. While the agency has published generally applicable environmental standards, these are vague, ambiguous, and operationally useless.[20] They do not include criteria for the disposal of high-level wastes. Proposed criteria for waste disposal have been under development for some time, but will not be published for comment for at least several months.[21] Without these criteria, there is no way to judge the adequacy of any proposed waste management scheme, for there is no standard of acceptability.

2. Site Selection Criteria

A major barrier utilized in the geologic disposal option is the geologic environment itself. Therefore, the selection of a site for location of a repository is a critical decision

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20/ See NRDC Comments on Criteria for Radioactive Waste Proposed by Environmental Protection Agency, 43 Fed. Reg. No. 221, November 15, 1978.

21/ Personal Communication, D. Eagen, EPA, June 24, 1980.

to be made in the early stages of repository development. The effectiveness of all other barriers will rely, at least in part, on the geologic environment chosen. For this reason, siting criteria should specifically prohibit locating repositories in areas with geologic features which could threaten their safe operation. As stated in the NRC draft technical criteria for regulating geologic disposal of high-level radioactive waste,

> Unfavorable site characteristics are identified to eliminate from consideration sites which would not be acceptable under any circumstances for a HLW geologic repository or which would present insuperable difficulties in terms of understanding the geology and hydrology of the site or would introduce or compound uncertainties which would affect negatively confidence in any licensing decision. 22/

Such characteristics include active faults, geothermal anomalies, aquifers of potable water which could be disrupted or contacted by the repository, known or potential mineral resources, and fractures which provide pathways for fluid movement.

DOE's site selection process is in conflict with the NRC approach. DOE has not incorporated an identification of unfavorable geologic characteristics into its site selection process. It has developed instead a set of siting criteria which are so general and vague that virtually any area could be found satisfactory for further investigation. Rather than specify features which would make a site unacceptable, DOE calls for an assessment of the risk created by the existence of these features at the site.

22/ Nuclear Regulatory Commission, Draft Technical Criteria for Regulating Geologic Disposal of High-Level Radioactive Waste, Enclosure "A" from Consent Calendar Item for the Commissioners from Robert B. Minogue, April 4, 1980, p. 5.

No site will be rejected unless the risk to the repository is judged to be "unacceptable."

The DOE criteria provide no guidance for the promulgation of criteria for specific projects. Thus it is probable that project criteria will rely, as do the general criteria, on an assessment of unacceptable impact or risk.

The NRC has not yet developed specific criteria for assessing the suitability of sites and disposal facilities.[23] At present, the NRC has only stated that such criteria are needed.

> Criteria by which the acceptability of the site/facility combination can be assessed are needed for this [likelihood that a given site would be suitable] determination.

NRC acknowledges that it may be impossible to determine such criteria:

> [There are] questions of whether or not, given the present state-of-the-art in the earth sciences, it is possible to identify on a generic basis site characteristics, the presence of which at an otherwise suitable site would render the site/facility combination unacceptable for HLW disposal. The question of general site acceptability criteria is an open one in the sense that the staff has not identified to date such criteria. Should general site acceptability criteria not be developed, it would be necessary to determine the site acceptability question on a case-by-case basis.

This "stepwise" approach is exactly the reverse of what is proper for the development of site selection criteria. It is as though, in a shooting competition, one first shot at a

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[23] 45 Fed. Reg. 31393, May 13, 1980.

blank wall, then later drew a target around the places where the shot hit. The approach guarantees that the criteria developed will be met, but in no way assures either that the criteria will be suitable or that they will result in the selection of safe sites. Until the NRC adopts site suitability criteria against which sites can be judged, there is no basis for confidence that the site selection process will produce an acceptable waste disposal site.

3. Performance Criteria

The NRC has set forth provisional technical performance criteria, including:

- The waste must be retrievable for 50 years post emplacement;
- There will be containment by the waste package for all radionuclides for the first 1,000 years;
- For the period beyond 1,000 years, there must not be releases of more than one part in 100,000 of the activity present in the HLW per year;
- The radionuclide travel times to the accessible environment must be at least 1,000 years;
- The suitable block of rock must extend beyond the repository for 2 km horizontally and 1 km vertically;
- Areas potentially attractive to human intrusion must be avoided;
- The various seals must provide barriers that are as effective as the undisturbed rock.

The DOE in its program plan does not even assert, to say nothing of demonstrate, that these NRC requirements have been satisfied. The program does not provide any evidence that any of these requirements can or will be met, much less that all of

them can or will be met at the same site. Instead the DOE program is geared to vague and flexible "objectives." As examples, the NRC requirements for retrievability, containment of fission products, and prevention of human intrusion are examined in detail.

a. Retrievability - The NRC draft repository performance criteria include the requirement that

> The Department of Energy . . . design the geologic repository operations area so that the radioactive waste stored there can be retrieved for a period of 50 years after termination of waste emplacement operations.

There is no evidence in the DOE program that 50 year retrievability can be accomplished. The 1978 ad hoc EPA review panel concluded that:

> Retrieval may only be feasible so long as an active crew is kept at the repository site, perhaps then for only a relatively short number of years, 5 to 10, while the repository is being filled. 24/

> Retrievability of HLW in other rock types [other than salt where there would also be migration of the canisters] is not so much a question of locating the canisters because they have bodily moved elsewhere, but being able to collect all of the waste because corrosion and leaching might so disintegrate the canisters that much of it is dispersed. . .25/

On the question of maintaining the integrity of the waste package, the panel observed:

24/ EPA/520/4-78-004, op cit., p. 3.

25/ Id., p. 43.

> It is unlikely . . . that the integrities of the canister, its contents, and its immediate surroundings will last very long, whether or not reprocessing is carried out. We have seen no evidence of survivals longer than a decade. 26/

Even if there were evidence from which to conclude that 50 year retrievability was possible, i.e., could be accomplished, there is nothing to indicate that DOE will provide for it. DOE does not appear to take seriously the NRC requirement on the need for retrievability. Retrievability is discussed in only the most general way in the Statement of Position, and DOE dismisses it by stating:

> Both limited and total retrieval are unlikely events, the latter being least likely. 27/

DOE has presented no evidence that it can and will meet the NRC retrievability criterion. Without confidence in this component of DOE's program, the NRC has insufficient assurance of the achievement of a safe disposal plan.

b. Containment of all fission products - The NRC draft criteria require

> containment of all radionuclides [within the waste package] for the first 1,000 years after decommissioning of the geologic repository operations. . .

There is no evidence that the DOE programs can or will meet this criteria. In fact, DOE's program "objectives" are fundamentally at variance with this proposed requirement. The DOE objectives call only for containment to be "virtually complete during the period when radiation and thermal output

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26/ Id., p. 44.

27/ DOE Statement of Position, p. II-283.

are dominated by fission product decay", and further state this will be done only "to the extent reasonably achievable." DOE also suggests that exposures of tens or more millirem per year would be permissible:

> Radiological consequences should be maintained within the level of variations in natural background radiation associated with geographic location and domestic activities.28/

Finally, DOE imposes an economic standard to govern the operation of a repository:

> The environmental impacts associated with waste disposal systems should be mitigated to the extent reasonably achievable. To the extent reasonably achievable means that which is shown to be reasonable considering the costs and benefits associated with potential mitigative measures . . . 29/

c. Development of Siting Criteria to Prevent Human Intrusion - The NRC draft technical criteria require the establishment of siting principles which will minimize the potential for human intrusion into a repository. Since the most likely activities to result in repository intrusion will involve exploration for natural resources and investigations of geophysical anomalies, these criteria should prohibit the location of a repository in an area with attractive natural features.

28/ DOE Statement of Position, p. II-6.

29/ Id., p. II-16.

DOE ignores recommendations for siting criteria which would prohibit the use of sites with valuable natural resources. It continues to consider salt as an acceptable repository host, despite the fact that bedded salt and/or salt domes are far more attractive resources than granite, shale, or basalt. The ad hoc panel commented on this fact in its report to EPA, calling the resource value of salt "an important negative socio-economic factor" in the use of certain potential repository sites.

> The most likely targets for near-term exploitation . . . are salt domes because of the potential productivity of petroleum, halite, and sulfur; and bedded salt deposits because of their potash, halite, and gypsum. The United States has only 4% of the world's total proven potash reserves, and most of these are concentrated in the New Mexico area now being evaluated as an HLW repository. Future conflicts between the demand for HLW repositories in bedded salt and the needs of agriculture for potash seem inevitable, and may even now constitute an important negative socio-economic factor in the development of some repositories.30/

The WIPP site in New Mexico is another example of DOE's disregard for siting principles which would reduce the hazard to future generations. The site includes known accumulations of potash, natural gas, and oil, all of which are valuable now and likely to become increasingly important in the future.

In this, as in the other areas discussed, there is no evidence that the DOE program can and will achieve a safe waste disposal plan.

30/ EPA/520/4-78-004, op cit., p. 40.

Two conclusions follow from the preceding discussion. First, the criteria necessary to judge the adequacy of DOE's waste management program are not yet available. Thus there can be no confidence that the program is adequate. Second, there is no evidence that DOE can and will comply with NRC draft criteria. In many instances DOE's program objectives conflict with the NRC criteria, with no apparent means for resolution. The bottom line must be that there is nothing in the DOE program on the subjects discussed which supports a finding of confidence in the waste disposal program.

B. None of the Specific Alternative Disposal Schemes, Media, and Sites Presently Being Pursued by DOE Provides a Basis for Assurance Now That Radioactive Wastes Will Be Disposed Of Safely.

The purpose of this section is to assess whether any of the specific alternative disposal schemes, media, and sites presently being pursued by the federal government provide a basis for assurance now that radioactive waste can be disposed of safely. The Interagency Review Group stated:

> The success or failure of the Federal Government's program for the management and ultimate disposal of radioactive wastes critically depends upon the choice of technical strategies. 31/

The DOE program has considered ten alternative disposal methods:

1. Mined Geologic disposal.
2. Subseabed disposal.
3. Very deep hole disposal.
4. Rock melting disposal.
5. Island disposal.
6. Ice sheet disposal.
7. Deep well injection disposal.
8. Space disposal.
9. Waste partitioning and transmutation.
10. Chemical resynthesis. 32/

31/ IRG Report, op. cit., p. 35.

32/ DOE Statement of Position, p. II-27.

Of these ten alternatives, only the first, mined geological disposal, is a viable candidate. On 12 February 1980, the President adopted an interim planning strategy focused on the use of mined geologic repositories.[33] Other alternatives lag far behind in development.

> [D]eep ocean sediment, and deep drill hole disposal [are] 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.[34]

Island, ice sheet, and deep well injection disposal and chemical resynthesis, variations of the above, have similar problems, do not appear to offer advantages, or are clearly unsuitable.[35] Consequently, none of the nine alternatives to mined geologic disposal can provide assurance now that radioactive waste can be safely disposed of. Thus, the remainder of this section will focus on the sole surviving candidate -- mined geologic disposal.

The rock types currently under consideration by DOE as host media for a repository are salt, granite, shale, tuff and basalt.[36] The DOE asserts that ". . . there are many places where potential host rock units of adequate volume exist at appropriate depths."[37] In no case, however, has DOE or anyone

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33/ Id., p. II-28.

34/ IRG Report, op. cit., p. 35.

35/ DOE Statement of Position, pp. II-28 to II-41.

36/ Id., p. II-72. The DOE has ongoing exploration programs to investigate salt in the Salina and Permian Basins and among the Gulf Interior Region salt domes and the domes in the Paradox Basin, basalt at the Waste Isolation Project on the DOE's Hanford Reservation, and volcanic tuff and granite at the DOE's Nevada Test Site.

37/ Id., p, II-72.

else identified a host rock unit of adequate volume and appropriate depth that also meets NRC draft technical criteria.

1. Salt

Draft NRC waste disposal criteria appear to rule out the use of salt as a host medium for a high-level nuclear waste repository. Salt has been, is, and will continue to be a valuable resource. It is often associated with other valuable resources, e.g., oil, gas, and potash. Mining of salt and exploration of other resources in and near salt deposits has occurred, and will continue to occur, probably at an accelerated rate. Thus salt can be eliminated generically under NRC criteria designed to avoid siting of repositories in areas where human activities could adversely affect the stability of the site, increase the migration of radionuclides from the repository, or provide pathways to the accessible environment.

Salt is plastic and highly corrosive. Consequently, salt also appears to be eliminated generically on the basis of the need to assure retrievability for a period of 50 years after termination of waste emplacement operations. Finally, because of the human intrusion problem, the corrosive nature of brine and its migration, salt appears to be eliminated on the basis of overall performance of the engineered system, that is, the ability to provide for total containment for 1,000 years and an annual release rate of one part in 10^5 of the total activity thereafter.

Clearly, the NRC does not have assurance now, on the basis of what is known about salt, that a repository can be built in

salt and still meet proposed NRC technical licensing criteria. Thus the NRC cannot provide assurance now that radioactive waste can be safely disposed of in the salt medium.

2. Basalt

The Basalt Waste Isolation Project (BWIP) is evaluating DOE's Hanford Site to determine whether it contains a suitable location for a repository in basalt.[38] Concerning this area, the EPA Ad Hoc Panel of Earth Scientists stated:

> The typical basalt flow of the Columbia and Snake River plateaus ranges from 10m to 45m in thickness, and is often separated from the overlying and underlying flows by an aquifer. Lower columnar and upper fan-type jointing of each individual flow is characteristic, and most lavas have a 5m thick vesicular zone at the top, and a 1m thick vesicular zone at the base of each flow. Thus it seems that, on the average, basalt should be far more porous and permeable than granite, and that it would also offer a higher risk of contaminating the ground water if used as an HLW repository.[39]

Similarly, the IRG Draft Subgroup Report on Alternative Technology Strategies states:

> Basalt on the Columbia Plateau commonly has zones of columnar joints or rubble that are potential channels for water movement. Water bearing sedimentary interbeds within the basalt section are common.[40]

Even the DOE acknowledges that questions about the location and movement of the water in the interbeds and interflows of Wanapum and Grande Ronde Basalts await resolution in the next

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38/ DOE Statement of Position, p. II-118.

39/ EPA/520/4-78-004, op cit., p. 22-23.

40/ IRG Report, TID-28818 (draft), Appendix A, p. 76.

2 to 3 years, and the tectonic conditions of the area only "appear" to be "sufficiently stable for siting a repository."41/

The Hanford site was selected for basalt investigation in large part because it is a DOE site and would therefore avoid the political and institutional problems associated with siting a facility "off the reservation." It was not chosen on the basis of its favorable geological characteristics. It should be noted that the National Academy of Sciences (NAS) conducted extensive studies of Hanford and other AEC sites, i.e., the Savannah River facility, Oak Ridge National Laboratory and the National Reactor Testing Station in Idaho. In its 1966 report the NAS concluded:

> Throughout the fabric of the 10-year history of the Committee's deliberations run some continuing threads of purpose and conviction. Prominent among them is the realization that none of the major sites at which radioactive wastes are being stored or disposed of is geologically suited for safe disposal of any manner of radioactive wastes other than very dilute, very low-level liquids, with the probable exception of grout injection into fractured shale at Oak Ridge. [Emphasis supplied.]42/

The above discussion suggests that the basalt at Hanford very likely will be excluded as a potential host rock for a radioactive waste repository because of the proximity of aquifers and the potential for radionuclide transport to the biosphere, and possibly on the basis of seismicity as well.

41/ DOE Statement of Position, p. II-118.

42/ NAS, 1966, p. 11.

Clearly, DOE's program provides no assurance to the NRC that radioactive waste can be stored safely in basalt, particularly the basalt formations at the Hanford site where the program addressing basalt disposal is currently focused.

3. Granite, Volcanic Tuffs, Shale, Argillite, and Alluvium

The Nevada Nuclear Waste Storage Investigations are evaluating the suitability of DOE's Nevada Test Site (NTS) for waste isolation.[43] Of the rock types that occur at NTS, argillite, granite, alluvium, and tuff have been considered for suitability as host rocks.[44] The test site area being examined is restricted by the need to avoid intereference with nuclear weapons testing. As with Hanford, the NTS site was selected because it was a DOE site and would avoid the political and institutional problems associated with siting a facility "off the reservation." It is clear that this site was not chosen on the basis of its preferred geology. In describing the area, the DOE states, "[t]he geology of the Nevada Test Site is complex, a characteristic shared by all of the Basin and Range Province in which the NTS is located." [Emphasis added.][45] General siting requirements of NRC's draft criteria c 11 for the selection of "relatively geologically simple sites" in order to compensate for geologic and hydrologic uncertainties. (Emphasis added.)

43/ DOE Statement of Position, p. II-118.

44/ Id., p. II-121.

45/ Id., p. II-118.

> The Department shall select the site and environs so that they are not so complex as to preclude thorough investigation and evaluation of the site characteristics that are important to demonstrating that the performance objectives . . . will be met. [Emphasis added.]

If this criterion is to have any meaning, it must exclude the NTS as a repository site.

"Alluvium was deferred from consideration as a candidate host for high-level wastes because its thermal conductivity . . . would allow unacceptable near-canister temperatures for 10-year-old high heat generating wastes."[46/] DOE investigations of NTS to date have also already excluded the Calico Hills (argillite-granite) and Wahmonie (granite) study area. "Magnetic and gravity data suggested a possible granite intrusion at shallow depth below the argillites at Calico Hills, but a 2,550-foot drill hole failed to penetrate the inferred granitic mass. . . . Therefore, current exploration efforts in the southwestern part of the Nevada Test Site are directed to locations containing the remaining candidate host rock, volcanic tuff. At present, only one location, Yucca Mountain . . . is being explored."[47/]

According to the IRG:

> The two forms of tuff of interest for repository use are quite different. The first form is densely welded tuff which has high density, low porosity and water content, and the capability to withstand high temperatures generated by radioactive waste. The compressive strength, thermal conductivity and thermal expansion of densely welded tuffs are comparable to those of basalt. Welded tuffs locally have significant fracture permeability and are important aquifers. . ..

46/ DOE Statement of Position, p. II-121.

47/ DOE Statement of Position, p. II-22.

> The second form of tuff of interest is zeolitic tuff which has low density, high porosity, very low interstitial permeability, a high water content and extremely high sorptive properties for radionuclides. Zeolitic tuff has moderate compressive strength and a moderate thermal conductivity. Dehydration of some zeolites begins at about 100 degrees C; unless the fluids released are able to escape through the rock, they will contribute to changes in stress state that could result in fracture. Heat may also cause some zeolites to decompose to new minerals with less sorptive capacity.
>
> The repository design concept is to place radioactive waste in the welded tuff with its high thermal stability and obtain a significant benefit from highly sorptive barriers of zeolitic tuff underlying and if possible also overlying the welded tuff. Local heating of the zeolitic tuff must be kept below that temperature where its beneficial properties are affected. A two year research program is under way at the Nevada Test Site to ascertain if welded tuff - zeolitic tuff sequences comprise a valid geologic repository medium. . ..48/

The DOE indicates that no such area has been found at NTS to date.

> Field mapping, core drilling, and geophysical surveying are in progress to assess the extent to which these conditions exist at Yucca Mountain. A 6,000-ft core and hydrologic test hole is being drilled into the study area; the results will be correlated with data from a 2,500-ft hole drilled earlier. . .. The water-bearing properties of inferred fracture zones in the Yucca Mountain area will be evaluated by hydrologic testing and geophysical surveys. 49/

While welded tuffs locally have significant fracture permeability and are important aquifers, DOE notes there are "few reliable estimates of ground water flow velocity are available for the NTS region."50/

48/ IRG, TID-28818 (draft), op. cit., pp. 78-79.

49/ DOE Statement of Position, p. II-122.

50/ Id., p. II-124.

Other than the NTS argillite, which has been excluded, the DOE is not actively exploring shale or shale-like formations, at least to the extent necessary to make even a rudimentary comparison against NRC Draft technical criteria.

Shale, like basalt, is usually interbedded with potential aquifers. Concerning shale, the IRG stated:

> A characteristic of shale which must be viewed as a potential drawback is the difficulty associated with mining and keeping the tunnels open. Inhomogeneities in shale that significantly affect its structural characteristics are difficult to identify in advance of mining. An example of such effects can be found in the Eleana argillite at the Nevada Test Site. Based upon core drilling there, it is estimated that about 20 percent of the volume of the shale is a highly plastic material that readily deforms to close unconstrained openings.[51]

Clearly, the NRC does not have assurance now on the basis of the DOE program that radioactive waste can be safely stored in alluvium, granite, argillite, shale, or volcanic tuffs, particularly at the NTS site where the disposal program addressing these host media is currently focused.

4. Other Media and Sites

Looking beyond the exploration efforts described above, there is nothing in the DOE program to provide a basis for confidence that radioactive waste can be disposed of safely. The program is only in its infancy. "The DOE's site exploration program is being expanded to consider a wider variety of rock types in diverse geologic environments. These broadened

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51/ IRG, TID-28818 (draft), Appendix A, p. 75.

activities were originally recommended by the IRG and were included in the President's statement of 12 February 1980."[52/]

There is no evidence from the DOE waste disposal program that any of the specific media or sites currently being explored provides reasonable assurance now that radioactive waste can be disposed of safely in those media and at those sites.

52/ DOE Statement of Position, p. II-125.

C. DOE Has Not Identified and Will Not Conduct the Research and Development Effort Necessary to Produce a Safe and Reliable Waste Disposal Program.

In order for the NRC to have confidence in DOE's ability to design, construct, and operate successfully a long-term nuclear waste repository system, it must have confidence in each of the essential elements of the disposal plan and the program designed to implement that plan. It is essential to the success of the entire program that research efforts be comprehensive. This means the efforts must (1) identify and address all the critical questions, (2) be properly directed to answer the questions, and

DOE's current research and development program is not designed to provide a comprehensive research effort. The program lacks coordination and specificity. Basic research tasks have not been defined and carried out in a systematic manner. In situ testing and the development of demonstration models essential to assess the merits of geologic disposal lag behind other, less important research efforts. Site work has been restricted mostly to federal reservations in order to avoid public conflict. The program ignores whole sets of important social, economic and political factors, and it includes no clearly defined organizational plan for implementation. In its haste to find a waste disposal solution, DOE has leapfrogged over basic research and planning steps which are critical to a successful program.

To further demonstrate the inadequacy of the DOE program, the following sections will examine in detail the deficiencies of

several important components of this research and development program.

1. The DOE Program Will Not Lead to an Adequate Waste Form

The form chosen for ultimate disposal of radioactive wastes is potentially the most important barrier to release of radioactivity. The ability of a waste form to remain inert and stable for thousands of years under a variety of conditions, including flooding, could prevent all releases to the biosphere. Unfortunately, although the selection of such a waste form has been the goal of past DOE efforts, none has been found.

Selection of a waste form must reflect an understanding of its potential alteration and interaction with the geologic repository. The waste form should be chosen for its stability in specific environments.

Glass continues to be the Department's "reference waste form," despite test results which cast doubt on its chemical stability:

> It has been demonstrated that glass in unlikely to remain unaltered in a typical repository environment, but would likely devitrify, crack, and ultimately, break down to form new mineral phases. These changes could occur within a relatively short time after closure of the repository. Thus, glass does not appear to fulfill the desired criterion of long-term endurance. 53/

The Department proposes to use glass in its study of the immobilization of high-level liquid wastes from the Western New York Nuclear Fuel Services Center:

53/ Donath, F.A., "Relation of Solids to Nuclear Waste Isolation," In Proceedings of the Conference on Solid Waste Forms, Denver, Colorado, December 19-21, 1978; Nuclear Regulatory Commission, NUREG/CP-0005, p. 27. See also, McCarth, G.J. et al., "Interactions Between Nuclear Waste and Surrounding Rock," Nature, Volume 273, p. 216-217, May 18, 1978.

> Glass will be used as the reference waste form for the immobilization process. Because of their advanced stage of development, borosilicate glass monoliths are utilized as the reference waste form in the analyses in this statement. 54/

Although DOE states that it intends to compare glass with other waste forms before it decides which form to use, there is very little data on other forms with which to make the comparison. A recent National Academy of Sciences panel stated that:

> The preference for glass as a waste form has been mistakenly based largely on the assumption that low leachability is the major criterion for solid waste performance, and on a misreading of the "stability" of glass under repository conditions. . .For wastes of high specific activity and thermal power density, research and development of waste forms other than glass should receive greater emphasis. 55/

A decision on the choice of waste form for ultimate disposal should not take place until sufficient data has been developed to make an adequate comparison of all the potential forms. However, in its haste to choose, DOE is opting for the technology which is most easily implemented today, regardless of whether it represents an acceptable choice for future waste containment.

Glass and metal or ceramic matrix are potent l forms for the high-level liquid wastes from reprocessing. A different set of conditions and potential chemical interactions must be studied for spent fuel. The NAS concluded that:

54/ 44 Federal Register 71859, "Compliance with the National Environmental Policy Act; Intent to Prepare Environmental Impact Statement and Conduct a Public Scoping Meeting," Department of Energy, December 12, 1979, p. 71860.

55/ National Academy of Sciences, Solidification of High-Level Radioactive Wastes, Pre-publication copy, September 1978, p. 63

Substantial analysis and experimental work are necessary to establish formally the feasibility of retrievable storage and/or disposal of spent fuel, and to define the method of preparation of the fuel assemblies.

2. The DOE Research and Development Program Does Not Adequately Address the Uncertainties Associated With the Selection of a Suitable Host Rock.

The DOE program has historically been almost exclusively directed towards the use of salt as a repository host medium. This early consideration of salt as a repository host was largely based on its high thermal conductivity, availability in areas of low seismicity, tendency to "self-heal" fractures, and dryness. Although these properties did make salt attractive for waste disposal, research has now uncovered significant problems with its geochemical and mechanical response to heat and to water. 56/ These problems are sufficiently severe to eliminate salt as a potential candidate medium.

Although salt has been shown to be an unsuitable medium, an acceptable medium has not been identified. Further, the R & D program developed for salt is now found to be unsuited for the investigation of other host rocks.

56/ An example of one such problem is the presence in salt of fluid inclusions which may cause corrosion of waste canisters. This trapped water, called brine, is saturated with salt and migrates towards heat sources. The brine nearest a heat source dissolves salt while precipitating salt further away from the source as well. Radioactive waste will cause brine to migrate towards it. This could increase the rate of corrosion of waste canisters, resulting in a breach of the waste form and leaching out of the wastes. Once this has occurred, containment of the radioactivity will be dependent on the host salt. However, the capacity of salt to immobilize the "fix" the waste is poor.

In addition to corrosion of waste canisters, the presence of and movement of brine may significantly weaken the mechanical properties of the salt mass. The salt could respond with increased creep rates, deformation and possibly melting.

The Department is beginning to study basalt, granite and shale as possible repository hosts. Problems with basalt as a disposal medium include: interbedded aquifers, columnar jointing, and mineralogic inhomogeneities. 57/ These problems require more accurate appraisal before the long-term effects of a repository in basalt can be evaluated. In situ tests at the Hanford Reservation may help to bound some of the uncertainties related to mechanical and thermal responses. 58/ However, the results of these tests will not be available until the mid-1980's.

Granitic rocks are attractive because they occur as massive dense blocks. These large masses of rock are generally impermeable, except when fractures allow the movement of water. Such fractures are present to varying degrees and are potentially induced by mining. 59/ A significant amount of research must be initiated to more clearly understand the problem of fracture permeability. A recent symposium on crystalline rocks discussed the research required to assess this problem and the difficulties with carrying it out.

> When examining fractured rock, a representative elementary volume may be larger than current testing machines can handle. . .Both conceptual

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57/ Interagency Review Group, 1978, Subgroup Report on Alternative Technology Strategies for the Isolation of Nuclear Waste, TID-28818 (Draft), Appendix A, p. 76.

58/Rockwell International, 1978 Basalt Waste Isolation Program Annual Report - Fiscal Year 1978, Informal Report RHO-78-100, p. 164.

59/ IRG Subgroup Report Appendix A, op. cit., p. 72.

> models and experimental investigations are therefore needed to allow confident extrapolation of laboratory data on fracture permeability to field occurrences. 60/

The major attraction of shale (argillacious rock) as a repository host rock is its low permeability and good sorptive characteristics. Significant drawbacks include its vertical and lateral inhomogeneities and difficulties associated with mining and keeping tunnels open. 61/ Important considerations for the feasibility of shale are water content and thermal stability. Little is known about the reaction of shale to mining and radioactive waste. Significant research is, therefore, required before an adequate assessment of shale as a repository host will be available.

It is clear that the DOE R & D program has not progressed sufficiently to identify which, if any, of host rocks is acceptalbe. One necessary task required by the NRC's draft technical performance criteria is in situ testing, which is discussed in the following section. These tests have not been conducted on any of the alternative candidate host rocks.

3. DOE Has Not Conducted Sufficient In Situ Testing

A central issue in evaluating the safety of geologic disposal of radioactive wastes is the interaction of the waste form and the host rock. The importance of this issue is highlighted by recent tests showing that vitrified high-level

60/ Lawrence Berkely Laboratory, Geotechnical Assessment and Instrumentation Needs for Nuclear Waste Isolation in Crystalline and Argillaceous Rocks, LBC-7096, p. 6, (1979).

61/ IRG Subgroup Report, Appendix A, p. 75.

radioactive wastes are not nearly as stable in the geologic repository environment as previously believed. Indeed, it is conservative to expect that during the post-operational lifetime of a repository the waste will contact the host rock under wet conditions. The chemical interactions will take place under varying temperatures and pressures, depending on the age of the waste at the time of contact and the repository design. The reactions which take place will influence the ability of groundwater to transport the radionuclides from the immediate vicinity of the repository. In addition to these geochemical reactions, heat from the repository may alter the mechanical stability and response of the rock mass.

The EPA Ad Hoc Panel of Earth Scientists identified the nature of part of the research effort required:

> Because the need for underground isolation of HLW has been recognized for some 30 years, the long postponement of pertinent research on rock other than salt is unfortunate. The problems will not be solved quickly. The research is inherently time-consuming because the critical data are attainable only from creep tests of months-long duration. Furthermore, the required testing machines (to accomodate 10-cm specimens, at temperatures of 500°C, under pressure of 200 bars, and for a duration of several thousand hours) do not even exist. It may take a major research effort of 5 years to build the necessary laboratory facilities; to collect adequate data; to develop realistic, three-dimensional, nonlinear, large deformation codes; and to validate predictions in the field. 62/

62/ U.S. Environmental Protection Agency, State of Geological Knowledge Regarding Potential Transport of High-level Radioactive Wastes From Deep Continental Respsitories; Report of an Ad Hoc Panel of Earth Scientists (1978), p. 14.

As the EPA Panel notes, the DOE does not have such a program in place. Furthermore, beyond laboratory tests and bench models, which will provide only limited insights into complex waste-rock interactions, large scale *in situ* tests are required to provide results which more accurately reflect repository conditions.

The importance of *in situ* tests is stressed in the NRC's proposed licensing procedures and technical criteria for regulating geologic waste repositories:

> . . .[T]he data needed to establish the ultimate suitability of the site is likely to be obtained only through exploration and *in situ* testing at depth, *i.e.*, in the proposed rock unit. . .. [W]ithout exploration and *in situ* testing in the proposed rock unit, neither the defects nor the key parameters can be determined with confidence. 63/

Based on these concerns, NRC is now requiring *in situ* determination of:

- the bulk geomechanical properties, pore pressures and ambient stress conditions of the host rock and surrounding confining units;
- the bulk hydrogeologic properties of the host rock and surrounding confining units;
- the bulk geochemical conditions, particularly the redox potential of the host rock and surrounding confining units;
- the bulk response of the host rock and surrounding confining units to the anticipated thermal loading given the pattern of fractures and other discontinuities and the heat transfer properties of the rock mass. 64/

63/ 44 Fed. Reg. 70410, December 6, 1979.

64/ 45 Fed. Reg. 31401, May 13 1980.

In the past, DOE has not aggressivley gathered data on waste/rock interactions. Past research on chemical interactions often did not take into account the high pressure and temperature conditions in an actual repository. Nor did these experiments identify the mineralogic properties of rock samples which were being used. 65/ Furthermore, none of these tests was in situ.

Because of DOE's failure to study waste/rock interactions in situ, data collection and verification lags far behind the optimistic estimates for repository construction and waste acceptance. Today only preliminary data exist on the in situ tests in granite at the Climax Stock in Nevada. Other tests have not even begun. For example, in situ heater tests in basalt will not commence at the Hanford Near-Surface Test Facility until late 1981. 66/ These tests are planned for completion by the "mid-1980's".

The applicability of the Hanford tests to actual repository conditions is already in doubt. The test is in a different basalt flow from the one being considered for repository location. A comparison of these two flows is being made, but the significance of any differences is physical properties is unknown. In addition, the design of the test facility is markedly different from the design of the proposed repository. In the test facility,

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65/ Report of an Ad Hoc Panel of Earth Scientists, op. cit.

66/ Rockwell International, Basalt Waste Isolation Project (BWIP) Annual Report, Fiscal Year 1979 (Nov. 1979), p. I-24.

heaters and spent fuel will be implaced vertically or parallel to the major fractures and joints in the basalt flow. The proposed repository design calls for emplacement of the fuel lying down or nearly perpendicular to the major joint patterns. The mechanical response of the basalt in these two configurations should be quite different.

In summary, there can be no confidence placed on the suitability of any geological medium pending successful conduction of both the laboratory and in situ testing.

4. DOE Has Not Developed the Technology for Successful Borehole and Shaft Sealing.

The USEPA AD Hoc Panel points out a paradox associated with selecting the location for a site:

> There is a fundamental paradox to be encountered in the design and construction of a "closed" repository. It is desirable to avoid disturbance of the rock mass by exploration drilling as this provides extra pathways for the HLW to reach the surface. However, one must determine very precisely the geometric distribution of rock properties throughout the future repository site and its immediate surroundings. Prior to excavation, only careful examination of many drill cores can possibly delineate these properties. These two contradictory demands must somehow be resolved. Proper assessments may have to await excavation of shafts and adits, despite the high risk of the capital investment should the site then be found to be unsuitable. 67/

If not properly sealed, boreholes and shafts may provide conduits for the release of radioactivity during all phases of repository operation.

67/ EPA Ad Hoc Panel of Earth Scientists Report, op. cit., pp. 43-44.

Recognizing this, the NRC is requiring that

> . . .[t]he sealed shafts and boreholes provide a barrier to radionuclide migration which is at least equivalent to the barrier provided the undisturbed rock. 68/

Past applications of sealing technology, to oil and gas wells and exploration boreholes, have been largely concerned with safety on the surface and not with ensuring that the entire length of the shaft or borehole remains dry and competent for thousands of years. Although this experience may provide a starting point for the development of sealing materials appropriate for repository application, the analogues have only been in existence for tens of years and have not been systematically tested over larged periods. 69/ In addition, sealing materials have never been systematically tested for their response to the varying temperatures and pressure conditions which can be expected in repository construction. 70/

Predicting the long-term integrity of sealing materials will require gathering data on the chemical interactions between the seal and the shaft linings and the surrounding rock mass. These interactions need to be studied under a variety of conditions with respect to contact with water, in situ as well as in the laboratory. Emplacement techniques for seals need to be developed with particular attention to sealing zones with fractured or disturbed rocks.

68/ 45 Fed. Reg. 3193, May 13, 1980.

69/ California Energy Resources Conservation and Development Commission Status of Nuclear Fuel Reprocessing, Spent Fuel Storage and High Level Waste Disposal, Draft Report, January 11, 1978, p. 166.

70/ Id.

Although these matters are being addressed to some degree by DOE, there is nothing in the R & D program which provides a basis for confidence that the program will be successful. For example, research funded by DOE is largely limited to borehole and shaft scaling in salt, and to a lesser extent, in basalt. 71 These projects support DOE's continued emphasis on salt despite its many problems, not the least of which may be corrosion of shaft casings and sealing materials. Research on borehole sealing of granite and shale lags so far behind that a study of research needs for these two rock types concluded:

> . . .the art of borehole, shaft and tunnel sealing for long-term confinement of nuclear waste is still in its infancy and. . .a comprehensive testing program will be required before the effectiveness of such seals can be known. 72/

Furthermore, DOE has yet to consider the problem of locating all the boreholes in the vicinity of repository sites. Boreholes used prior to repository construction for exploration and/or geophysical studies may be present in a site in large numbers.

71/ Office of Nuclear Waste Isolation, "The Status of Borehole Plugging and Shaft Sealing for Geologic Isolation of Radioactive Waste," Report No. ONWI-15 (January 1979); U.G. Geological Survey, Earth Science Technical Plan for Disposal of Radioactive Waste in a Mined Repository; Draft, April, 1980.

72/ Lawrence Berkely Laboratory, Geotechnical Assessment and Instrumentation Needs for Nuclear Waste Isolation in Crystalline and Aigillaceous Rocks, Proceedings, July 16-20, 1979, p. 133.

5. The DOE Program Does not Adequately Identify and Resolve the Problems Inherent in Short and Long Term Repository Monitoring

There are two aspects to the monitoring of the repository that must be considered: (1) health physics monitoring during the operational phase for occupational and population exposure and (2) monitoring for collection of data to determine whether the repository is capable of meeting the predetermined performance criteria.

Experience with the day-to-day health physics monitoring of radioactive waste management facilities operated by DOE offers little confidence that this aspect of radioactive waste disposal will be adequately conducted. Monitoring programs have frequently failed to collect the data necessary to accurately predict the presence or extent of a problem. They have not included a periodic review of procedures. Nor have they provided plans for follow-up actions once a problem has been detected.

An example of these deficiencies is the program designed to monitor the high-level radioactive waste storage tanks at the Hanford Reservation. 73/ The Hanford program, which collects data on 90 tanks containing radioactive waste, categorizes the tanks according to whether leakage is occurring. A recent report by the Inspector General of DOE concluded that both the type of measurements being made and the categories used -- "Questionable Integrity" and "Confirmed Leakers" -- were not

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73/ DOE Office of Inspector General, January 22, 1980.

useful for determining the extent of tank leaks. Furthermore, there was no provision in the program for a periodic review of the procedures. If reports of tank leakage had not been made by an employee of the contractor, it is questionable whether a review would have ever taken place.

The Hanford example demonstrates the need to develop technical information and engineering and organizational systems for future monitoring programs. It also points out the need to plan for mitigation measures to deal with discovered leakage or other problems.

The success of a monitoring program is an indication of society's ability to design and implement a system with both technical and human components. The experience with monitoring thus far indicates that, even for the short term, there is little basis for confidence that such systems will function as designed. DOE has not demonstrated that it can adequately monitory existing waste storage facilities, to say nothing of a long-term repository holding several times the waste it presently oversees. The record of this experience does not justify NRC confidence.

The monitoring uncertainties described above result from a lack of adequate planning and/or the failure of the human factor in the program. These problems assume even greater significance for the monitoring program necessary to obtain confirmatory data on repository performance. This is the case because neither the

nature of the monitoring nor the period of time for which it will be required have been determined.

Concerning the time frame required for monitoring, the IRG Report states:

> It should be emphasized that models validated by in situ testing for short-term (operational period) and near-field mechanical effects cannot be validated for long-term and far-field effects because of the great length of time required for measurable mechanical effects to be realized at large distances from the repository. Confidence in the ability of such models to predict far-field deformations over long periods of time must necessarily be based on the accuracy of short-term predictions and on increased understanding of long-term processes. Monitoring, for some period yet to be determined, will be useful to assure the accuracy of the predictive models for the short-term, and to provide an early warning should the models prove to be unreliable. (emphasis added) 74/

With respect to both the nature of the monitoring and the time frame to be involved, the EPA Ad Hoc Panel states:

> As noted in the text, there are also several questions, notably the determination of real permeabilities and porosities in the rocks at a site, or the nature of the long-term monitoring systems, answers to which must await the intervention of new technology. The time scale for such research is much less readily determined. 75/

It is inconceivable that the NRC could find any basis for confidence concerning the disposal of spent fuel, given the uncertainties involved in the requirements for short and long term monitoring, some of which have not even been identified at this time.

74/ IRG, op. cit. TID 28818, Appendix A, pp. 34-35.

75/ USEPA, Ad Hoc Panel of Earth Scientists, op. cit., p. 45.

6. The DOE Program Places Undue Reliance on Risk Assessment to Determine Repository Performance

The DOE waste disposal program relies heavily on risk assessment modeling to evaluate the performance of proposed geologic repositories and to support its contention that radioactive waste can be disposed of safely, and, by implication, that the NRC should find confidence in its waste disposal program. However, changes in the geologic environment and the uncertainties associated with the infancy of repository technology make predictions of long-term performance potentially very unreliable.

Furthermore, design and utilization of risk assessment models depends, at a minimum, upon the following: an understanding of the processes which will influence the migration of nuclides in the event of failure of the repository; empirical and experimental data characterizing the environment, the waste and the interaction of the two; estimates of the probability of occurrence of natural geologic events and engineering failure; and the characterization of potential future scenarios.

The deficiencies in available data and current knowledge about all of these factors prevent the preparation of an accurate model which can correctly represent the risks of long-term storage. Dr. Fred Donath, a geologist familiar with the limitations of risk assessment, has stated:

> The accuracy of the risk assessment will be directly proportional to the degree of understanding of the system under analysis, the adequacy of mathematical models to describe phenomena of significance to the system, and the completeness and accuracy of the data. . .Given the uncertainties associated

> with our predictive capabilities in the earth sciences, with the ncessary mathematical oversimplication of complex processes, and with the variability of rock properties and hydrogeologic characteristics, a precise risk assessment of nuclear waste disposal in deep geologic formations may never be possible. 76/

Even the best models cannot make up for a lack of data or for incomplete understanding of the system being modeled. For this reason, the NRC, in proposing technical criteria for geologic repositories, specifically limited the extent to which one can rely on modeling results:

> The lack of empirical data on the performance of engineered barriers or the inability to obtain credible data may preclude the development or use of credible quantitative models in the showing that either the uncertainties are addressed properly in the performance standards or the performance standards are met in a particular licensing action.
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> . . .
>
> In sum, the staff considers the following to be a reasonable position with respect to the use of models:
> Technical criteria must be developed through a rulemaking process in which the logic and factual basis in clearly articulated and can withstand challenge. Hence, where appropriate, quantitative models should be used to develop technical criteria. However, because of the limitations discussed above, it is desirable to specify technical criteria associated with the regulatable elements in such a manner as not to predicate their technical justification on the results of quantitative modeling, except in those instances where quantitative modeling can contribute to their technical justification. Where quantification is not possible, without meaning, incomplete or ambiguous, the process must rely on expert opinion to provide insight and alternatives. 77/

76/ Donath, Fred A., "The Role of Scientific Advisory Groups: Disposal of High Level Nuclear Waste", Report of The GSA Committee on Geology and Public Policy, Geological Society of America, (August 1979) p. 16.

77/ 45 Fed. Reg. 31398, May 13, 1980.

One important example of the unavailability of good parametric data for the preparation of reliable risk assessment models is the groundwater transport of radionuclides. Groundwater transport is the most likely release mechanism for radionuclides, barring physical intrusion of the repository. For this reason, understanding the constraints of groundwater systems and modeling the flow through them are of major importance to insuring waste isolation. The information needed for this effort -- and the uncertainty of its compilation -- have been summarized by the U.S. Geological Survey:

> We need, at a minimum, the permeability and porosity of the media and the hydraulic head gradients in all three dimensions. In addition, we need to know the sorptive characteristics of the media along all paths, and we need to estimate the variable rates at which the solidifed wastes will enter the transporting fluids. Needed, in particular, is information on the distribution and extent of major heterogeneities. The need for such data severely taxes both the available data base and the technology for generating it. 78/

The unavailability of critical data in this area has also been noticed by the Interagency Review Group.

> [A]ccurate prediction of the transport of radionuclides from a repository requires detailed knowledge. . .These types of hydrogeologic and geochemical information are currently not fully available even for the best known aquifers,. . .[M]oreover, obtaining some of the above information for fractured media or for porous media of very low permeability will have to await methodology development. 79/

78/ Bredehoeft, J.D., England,A.W., Stewart,D.B., Trask,N.J., & Winograd, I.J., "Geologic Disposal of High-Level Radioactive Waste-Earth-Sciences Perspectives," U.S. Geological Survey Circular 779 (October, 1979).

79/ Interagency Review Group Report, op. cit., p. 39.

In fact, the USGS has stated that we do not yet know how to obtain the needed information.

> Some measure of the uncertainties associated with the results of risk assessment models is needed, but it is not clear at present how this can be obtained. The probabilities calculated for rare geologic events do not lend themselves to estimates of formal error; upper bounds are much easier to determine and justify. . .[I]n a complex integrated model of a total waste isolation system, calculation of formal uncertainty can be very lengthy and may be unrealistic if all variables do not have uncertainties that can be incorporated mathematically (for example, variables associated with human intrusion). Parametric and sensitivity studies coupled with conservative siting and engineering practices with regard to crucial components of the system may be the best way to provide confidence in repository performance. 80/

The EPA Ad Hoc Panel reached the same conclusion:

> As noted in the text, there are also several questions, notably the determination of real permeabilities and porosities in the rocks at a site, or the nature of the long-term monitoring systems, answers to which must await the intervention of new technology. The tiem scale for such research is much less readily determined. 81/

The selection of a site with an understandable and acceptable hydrologic system is essential both for successfully modelling the system and using the model to control radiological transport by groundwater. Unfortunately, hydrologic systems change with time, and uncertainties may arise in the future regarding the effects of these changes on repository integrity.

80/ Bredehoeft et al., op. cit., p. 12

81/ EPA Ad Hoc Panel Report, op. cit., p. 45.

Another aspect of radionuclide transport in the hydrologic system which has provide troublesome for DOE is the potential sorption of nuclides by rocks in the pathway, resulting in slow migration away from the repository. Sorption of radionuclides by rocks is both difficult to measure and to verify. Field verification of hyrologic models and sorption data, among other equally important factors, is essential. Past studies relied on laboratory batch tests and the determination of sorption coefficients which may not be accurate representations of conditions in the real geologic environment. The data collected for many rocks were not comparable due to poor characterization of both the rock materials and the waste and the varying temperatures and pressures used in each test. 82/ Furthermore, little data exists for the high pressure and temperature conditions which will prevail in the repository. Another problem with existing laboratory data is the time span over which measurements were made. 83/ The actual chemical processes will differ with the length of time.

In conclusion, there is no basis whatsoever for a finding of confidence that the radioactive wastes can be disposed of safely founded on mathematical modeling of risks associated with the performance of a geologic repository.

82/ USEPA, Report of Ad Hoc Panel of Earth Scientists, op. cit.

83/ Lawrence Berkely Laboratory GAIN Symposium, op. cit.

D. DOE Has Not Identified or Addressed the Social, Political and Economic Issues Involved in Implementation of a Safe, Reliable and Publicly Acceptable Waste Disposal Program.

The management and disposal of radioactive waste is not simply a technical problem. Technolgies are not self implementing. The success of any waste management program will depend as much upon its social, organizational and institutional features as on its designs and engineering. An NRC task force concluded in 1978 that the "past failures of proposed radioactive waste management systems have stemmed in large part from neglect of nontechnological necessities in [the] implementation. . .of systems." 84/ In 1979 the Interagency Review Group on Nuclear Waste Management reported to the President that "the resolution of institutional issues. . . is equally as important as the resolution of outstanding technical issues and problems," and that such resolution "may well be more difficult than finding solutions to remaining technical problems."85/

Despite these warnings, neither the NRC nor the DOE has come to grips with the significance of the implementational issues. In fact, DOE has only just recognized that these issues even exist. It recently requested the National Research Council to "attempt to identify social and economic issues to be considered in selection of respository sites" in order to "recommend ways in which to take various social and economic impacts into account in site selection. .. ."86/

84/ W.P. Bishop, N. Hilberry, I.R. Hoos, D.S. Metlay, and R.A. Watson, (eds.), Essays on Issues Relevant to the Regulation of Radioactive Waste Management, NUREG-0412, (Washington: U.S. Nuclear Regulatory Commission, 1978), 57.

85/ Interagency Review Group on Nuclear Waste Management, Report to the President, TID-29442 (U.S. Department of Energy, Washington, D.C., 1979), p. 87.

86/ National Academy of Sciences, News Report, Vol. XXX, No. 6, June, 1980.

As a result, the Statement of Position contains little discussion of the broad range of social, political, and institutional problems facing the waste disposal program, although a number of studies have identified these matters of public concern as the real obstacles to its success. One of these studies, from the Institute of Governmental Studies at the University of California at Berkeley, cautions that not to consider public concerns as an integral part of the planning process for waste disposal is to "run the risk of serious political opposition" which may doom an otherwise acceptable program. 87/

In order to be successful the DOE program must be designed to meet dual objectives. First, it must be a program which the public sees as legitimate and in which it has confidence, and second, it must provide reliable and safe waste disposal operations. If the first objective cannot be met, the nation may be unwilling to commit the necessary political, technical and economic resources to carry out the chosen method, and thus the method will fail.

Achievement of the first objective requires the identification and assessment of the relevant social and institutional obstacles to implementation in the major phases of the waste disposal program, including the initial phase of siting, construction and licensing of the first waste repository, the second phase in which the program expands to cope with the increased volume of wastes produced by the current and near future generation of light water reactors

87/ G.I. Rochlin, C. Demchak, T. Hershberger, G. Hoberg, Jr., T.R. LaPorte, P. Windham, Social and Institutional Aspects of Radio-Active Waste Management: Some Preliminary Findings, 195/RW 001 (October 1979), S.3.

and the long-term management phase in which the technology and institutional arrangements previously created will be tested over long periods of time. In each of these phases new issues will present themselves for resolution, and social, political, and organizational arrangements appropriate to an earlier phase may require modification.

1. Initial Start Up Phase

The phase of greatest concern at present, and the focus of the waste confidence proceedings, is the initial start up phase of the waste disposal program. DOE is compelled to develop a waste disposal program which can and will be implemented successfully before the expiration of current facility licenses. Failure to do this threatens the continued viability of the domestic nuclear program, the substantial investment made by utilities and the industry, and, to a significant extent, public confidence in the ability of government to act decisively on a major social issue. The historical development of nuclear power in the United States has inextricably linked the federal government to the nuclear industry. Thus, the implementation of a waste disposal system is seen as a governmental responsibility.

The initial phase presents the greatest number of social and political uncertainties. These have been identified and discussed in the 1977 Report of the Task Force for Review of Nuclear Waste Management (referred to as the Deutch Report) 88/

88/ DOE/ER-004/D, UC-70 (1978).

and in the work of G.I. Rochlin and R. Kasperson, among others. [89] Some of the key social and political obstacles are discussed in detail below.

a. Public Opposition and Lack of Trust

Foremost among the obstacles to implementation of the DOE program is the serious level of public opposition to nuclear power in general, and waste disposal locations in particular. [90] This is coupled with an increasing lack of trust in the ability of the institutions charged with the responsibility of protecting the public from the hazards of radiation to adequately carry out that responsibility.

The unwillingness of the public to accept an overall waste management program manifests itself in the efforts of town, counties, and states to restrict or eliminate the ability of federal authority to transport or store wastes within their political boundaries. As of October, 1979, 19 states had enacted legislation aimed at banning or delaying the siting of waste repositories and 18 had passed laws restricting the transportation of wastes. By May, 1978, 33 states had passed laws directed in some fashion toward the control of radioactive wastes. [91]

89/ See, for example, the IGS Study previously cited, and the testimony of Roger Kasperson entitled "Institutional and Social Uncertainties in Radioactive Waste Management" presented to the Ohio Power Siting Commission, June 27, 1978.

90/ Report of the General Accounting Office, Comptroller General of the United States, (September 1977).

91/ Roger Kasperson, private communication; NRC Office of State Programs, Information Report on State Legislation (1978).

President Carter, in his statement of February 12, 1980, outlined a process of "consultation and concurrence" as a means of resolving differences between the states and the federal government over the siting of waste disposal facilities. The idea implicit in this policy is that the sharing of information will lead to agreement on siting questions. However, there is doubt that simple information sharing will eliminate or even reduce the increasing reluctance of the states to be chosen as waste dumping grounds. Kai Lee observes:

> [T]he history of nuclear waste management makes the DOE and other federal agencies unlikely allies of the states. The inclusion of state governments in national decision-making, although important in principle, must be designed with attention to its practical political feasibility. To draw in the states as the new federal policy does, siding with the national government and one of its most controversial agencies, may fritter away one of the few sources of legitimacy left in an already tattered political fabric.

Furthermore, the policy provides no means for working out cases of non-concurrence. It appears that state disapproval can effectively halt federal efforts to site a waste disposal facility, pre-emption arguments notwithstanding. Even if this is not correct, it is difficult to imagine how a repository could be safely sited and operated if the state of its location was strongly opposed. Lack of cooperation by state authority could pose substantial problems in implementation, yet this question has not been addressed by DOE.

b. Questions of Equity

Closely tied to the problems of public acceptance are questions of equity. Because the benefits and risks of nuclear power are not shared equally around the nation, some members of the public will be asked to bear the risk of waste disposal for others. The degree of opposition at the local level indicates how the public feels about this burden.

The success of the waste disposal program will depend upon the development of siting principles which reflect both systematic analyses of various social, political and economic environments, and determinations of fairness and justice in allocation of the risk. 92/ No such systematic analysis has been conducted by DOE. Consideration of fairness and justice must be applied both spacially and temporally. The latter relates primarily to the intergenerational transfer of

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92/ Rochlin et al. include in their study of the "Social and Institutional Aspects of Waste Management" a table which lists the kinds of information which should be collected about the social, economic and political characteristics of representative or potential repository sites. Some examples include:

- sociological data:
  - urban/rural mix
  - professional/non-professional mix
  - racial and ethnographic data
  - age, sex, and family data
- political profile:
  - attitudes towards nuclear power generally
  - sensitivity to local, extended, and global environmental issues
  - attitudes towards remote, centralized authority (state and/or federal)
  - historical local independence and self-sufficiency
- social profile:
  - activities
  - mobility
  - degree of social stratification
  - lifestyle preferences
  - median education level
  - typical wages/salaries
  - seasonal and migratory labor patterns, if any (Table 3.B.3., p. 3.32)

Data of this sort if notably absent from the DOE Statement of Position.

the risks associated with waste disposal, the former to the "not in my backyard" syndrome. A comprehensive approach to considerations of justice must also address the issue of compensation of the members of the public who live near a waste repository.

DOE fails to confront any of these issues in a direct or comprehensive way. Its views must be inferred from its adoption, as Objective 6 of the program, of President Carter's requirement that "[t]he responsibility for resolving military and civilian waste management problems shall not be deferred to future generations," 93/ and its meager discussion of "Social Concerns" which alleges, without reference or support, that "there is growing public recognition that nuclear waste management is a national problem and that solutions to the problem should not be postponed for future generations." 94/

c. Changes in Regulatory Policy

As discussed earlier, the history of the waste disposal program in the United States is a story of fits and starts and major changes of direction and focus. DOE and its predecessors have seized upon a single disposal scenario, only to be forced to begin nearly anew when it proved unfeasible or basic assumptions were altered. As discussed below, it is highly likely that developments nationally, particularly in the Congress, will result in further redirections of the program. There is no basis for assuming, particularly in light of the history of the program and recent Congressional attitudes, that these redirections will be an improvement.

93/ DOE Statement of Position, II.A.1.3., p. II-18.

94/ Id., III.F.2.2.2., P. III-87.

d) Managerial and Regulatory Uncertainties

In Kasperson's view, "managerial and regulatory issues constitute perhaps the most formidable obstacles to a timely resolution of the radioactive waste problem." 95/ Of particular concern is the absence of a mechanism to coordinate all the departments within the federal government which have responsibility for nuclear waste. 96/

Nine different institutions share responsibility for radioactive waste matters. 97/ Three of these were created in 1980,

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95/ Roger Kasperson, "Institutional and Social Uncertainties in Radioactive Waste Management," op. cit., p. 20.

96/ The DOE Statement of Position states that arrangements are being made for interagency cooperation among a few of the organizations concerned with waste management. III.O.2., p. III-42. However, these are far from complete. The necessary memoranda of understanding have not been prepared, much less the substantive procedures required for collaboration and implementation of the program. See Section III O.2.1.1., p. III-42.

Furthermore, the existence of cooperative arrangements does not supplement the need for a means of over-all coordination of the waste management effort. As "lead agency" for the development of a waste disposal method, DOE should function in this capacity. It is apparent from the Statement of Position that it does not.

97/ The Nuclear Regulatory Commission, the Department of Energy, the Environmental Protection Agency, the Department of Transportation, the U.S. Geological Survey, the Council on Environmental Quality, the Office of Science and Technology Policy, the Federal Radiation Policy Council, the Nuclear Safety Oversight Committee and the State Planning Council.

adding to the confusion and potential for conflict.[98] Each of these organizations has its own mandate and agenda, its own opinions on the appropriate shape and course of the waste disposal program. Consensus is notably lacking that the program will produce a safe method of disposing of wastes within a reasonable time period. For example, the U.S. Geological Survey has expressed doubts about the adequacy of the technical information supporting the program and the validity of the geological assumptions used.[99] The Office of Science and Technology Policy has stated its opinion that "the knowledge and technology base available today is not sufficient to permit complete confidence in the safety of any particular repository design or the suitability of any particular site." [100]

A significant reason for the lack of confidence in DOE's program among other agencies is the fact that DOE has still not determined what must be done to design and implement a waste disposal program. (See discussion in Section V of this statement.) The Statement of Position notes that DOE is presently

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98/ J.D. Bredehoeft, et al., Geological Disposal of High-Level Radioactive Wastes -- Earth Science Perspectives, U.S. Geological Survey Circular 779 (Reston, VA: USGS, 1978).

99/ Luther J. Carter, "Nuclear Wastes: The Science of Geologic Disposal Seen as Weak," Science, 200 (1978), 1135.

100/ The Federal Radiation Council is responsible for the development of federal radiation protection policy. It will review actions of the NRC which affect public and worker health. The Nuclear Safety Oversight Committee is charged with overseeing industry and government programs in improving reactor safety. The State Planning Council has responsibilities for coordination of waste policy between the federal and state and local governments.

trying "to define the technical efforts required for successful mined geologic waste disposal." These include "site identification and characterization, rock mechanics, repository sealing, waste/media interactions and repository performance assessment "[101], matters which should have been the subject of initial research at the beginning of the waste disposal program. It is astonishing to find DOE attempting to "define the technical efforts required" for successful achievement of a program which is more than 20 years old.

Because DOE does not have a clear idea of what is required for implementation of the program, it cannot integrate the work of other agencies into its own or direct their efforts in a meaningful way. No priorities have been established within the various agency programs based on the overall schedule. Nor are the individual agencies fully aware of the efforts and schedules of other organizations.

A potentially more serious problem is the lack of consistency in the programs and schedules of various agencies. For example, DOE began searching for repository sites several years before the NRC promulgated its site suitability criteria. The NRC's approach to siting is different from that of DOE, as previously discussed, which may result in selection of a site

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[101] DOE Statement of Position, III. D.1.1.1., p. III-44.

which is unacceptable to one or the other agency. In fact, this has already occurred with the choice of the site for the Waste Isolation Pilot Plant (WIPP). WIPP has significant potash deposits, although the NRC criteria would prohibit the location of a repository at a site with valuable mineral resources.

DOE acknowledges that the NRC's procedural requirements for licensing a waste repository could have a "major impact on costs and schedule." In fact, these requirements could mean the success or failure of the DOE program.

A second aspect of the problem of management and regulatory uncertainties is the existence of gaps in the licensing authority of the Nuclear Regulatory Commission. The Atomic Energy Act of 1954 and the Energy Reorganization Act of 1974 have exempted certain activities of DOE and its contractors from regulation by the NRC. Of particular relevance to the waste confidence proceeding is the fact that the NRC has no authority to license either a facility used by DOE for "research and development" or a facility used for the "short term" handling, treatment or storage of high level waste. Although the Energy Reorganization Act does not define it, the NRC considers storage of less than 20 years to be short term. It is also possible that DOE spent fuel might not be considered high level waste and therefore not subject to NRC authority.

These uncertainties undermine the ability of the NRC to have confidence that an adequate program can be implemented

within the requisite time frame. Without sufficient authority to regulate important aspects of the waste disposal program, it will be difficult for the NRC to assure the public that the overall program is safe.

A third aspect of managerial and regulatory uncertainty is the conflict between the DOE program and the Congress. Although DOE has chosen to pursue geologic disposal, Congress has not made a similar commitment to this option. Various bills are before the Senate and House Committees. The primary issues addressed in these bills include:

1. Interim management of spent fuel, including the proposed AFR program;
2. The role of state and local government and the public in the geologic storage program;
3. The geologic storage program, including the setting of timetables for demonstration repositories and other work;
4. The proposed use of long-term surface storage facilities (different from AFR's) for high-level waste;
5. Low-level waste management;
6. Extension of NRC licensing authority to DOE facilities;
7. The question of making continued operation of the nuclear power program legally contingent upon demonstrated progress in nuclear waste management programs.

There are serious efforts to undercut some of the most important features of the President's nuclear waste policy. For example, the Energy and Water Development Appropriations Bill for Fiscal Year 1981 which passed the House on June 25, 1980 provides

only $199,477,000 of the requested $245,337,000 of funds for commercial waste management.

The House-passed bill provides only $175,551,000 of the requested $219,651,000 for commercial nuclear waste management operating expenses. Cuts were made in terminal isolation research and development ($157,439,000 v. $192,939,000), waste treatment technology ($14,850,000 v. $17,450,000), and support programs ($1,500,000 v. $7,500,000).

These reductions are representative of the Committee's overall opposition to the President's proposals. The Committee Report states:

> The committee believes that there should be a major redirection of effort in this program in order to resolve nuclear waste management questions much earlier and much more economically than the Administration has proposed. (p. 22)
>
> The Committee included the following ways of redirecting the effort:
>
> 1. increased emphasis on the construction and demonstration of a long-term engineered storage facility for nuclear wastes and aged spent fuel.
>
> 2. increased effort on the development and demonstration of technology for handling and processing and nuclear waste materials and the development of engineered barriers, including waste solidification and overpack cannisters, so that nuclear waste cannisters can be considered safe for disposal even in a most hostile geologic environment.
>
> 3. increased emphasis on using existing federally owned sites which have already been subject to radiation effects for long-term storage or disposal.
>
> 4. increased emphasis on the recovery of noble metals and other potentially valuable products and uses of nuclear waste prior to preparation for final disposal.

demonstration repositories, the first to be in operation by 1986. Contrary to the IRG recommendations and the President's policy, these repositories would not be licensed by the NRC and would be subjected to limited state and local participation.

Confidence in the waste disposal program must reflect assurance that its various parts are not working at cross purposes. Congress and the Executive Branch agencies with responsibility for the problem must share a common view of what is required to solve it. This cannot be said at present. Confidence also requires assurance that funds adequate to develop, install and maintain waste disposal facilities will be allocated and that the NRC will have the authority to license waste disposal facilities.

2. The Second Phase -- Scaling Up

The entire focus of the DOE program is on the location, construction, and operation of one repository, designed to retain the wastes DOE anticipates will be produced by the year 2000. 102/

However, for the purposes of this proceeding the NRC must also determine whether there is any basis for confidence that DOE can and will design, construct, and operate the additional disposal facilities which will be required immediately after the first such repository has been built. If confidence is found in the first facility site, DOE will have to address the technical and organizational problems of "scaling-up" to a disposal system capable of accommodating wastes from an expanding nuclear industry. The DOE Statement simply does not analyze the various organizational or institutional problems which are inherent in the inevitable next phase of waste disposal.

102/ DOE Statement of Position pp. III - 22, 57-59, 77.

The first and most basic premise is that the waste disposal system must be essentially error-free from the outset. As has been recognized by several experts, "the incremental approach to perfect performance...is explicitly not an option for the waste management program."[103] The aroused opposition to nuclear power which was stimulated by the accident at Three Mile Island indicates that the public simply will not tolerate a normal "learning curve" in this area.

Second, the organization required to support an expanded network of disposal sites will have different and more serious problems than those confronting the waste disposal program for one repository. In part, this is due to the application of that "bit of organizational folklore, Murphy's Law":

> The larger the volume of waste materials and the more varied its composition, the larger and more complicated the total system is likely to be; and the more complicated the system, the more we are prone to imagine that if anything can go wrong, invariably it will at some time or another.[104]

To put it another way, the organizational complexity of an expanded waste disposal program is not linear with its size. As more waste repositories are needed, the problems associated with site selection, facility design, security, transporataion, etc., are multiplied, wholly apart from the purely technical problems involved. As the accident at Three Mile Island demonstrated, the least reliable factor in an elaborate scheme to control nuclear dangers is the human factor. This fact will become increasingly crucial as the program expands.

103/ G.I. Rochlin, et al, "Social and Institutional Aspects of Radioactive Waste Management," op cit, p. 3.47

104/ Todd La Porte, "Nuclear Waste: Increasing Scale and Socio-political Impacts" Science, Vol. 201, July 7, 1978, p. 26.

> As the volume of wastes increases, the most crucial scarce resource may well become the people who are highly skilled and who can be motivated sufficiently to perform continuously at extraordinarily high levels of reliability, even though it is likely that the jobs will generally be routine and boring on a day-to-day basis.[105]

Increased dependence on human reliability requires that the organization be equipped with an "error detection mechanism" which will "reward detection and correction of error rather than its denial or cover-up."[106] Nothing in the DOE program is responsive to this problem.

Third, there is no indication that DOE has analyzed the impact of an expanded waste disposal system on the social structure of the communities directly affected. DOE's bland assumption that "social concerns" about the safety of nuclear waste disposal will be resolved because of the "growing public recognition that nuclear waste management is a national problem"[107] ignores a critical set of issues that, in and or themselves, could lead to rejection of a waste management program. For example, it is not known whether DOE envisions locating a series of waste repositories at one site or region, or spreading them out in various locations across the nation. The ethical, economic, and political implications of either of these strategies is not discussed. Until these issues are addressed, DOE's waste management program is seriously inadequate.

105/ Id., p. 23.

106/ G. I Rochlin et al., "Social and Institutional Aspects of Radioactive Waste Management," op cit, p. 3.47.

107/ DOE Statement of Position, p. III - 87.

Finally, DOE has failed to provide a detailed cost estimate of a comprehensive waste management program. The need for organizational refinement and superior personnel necessarily leads to a high cost program -- a cost which may be disproportionate to the "benefits" of nuclear power production. Moreover, the cost to our civil liberties from an authoritarian waste disposal bureaucracy which decides which communities become perpetual hazardous dumping grounds may be too great for our society to bear.

3. The Long Term Management Phase

The final phase of the waste disposal program which must be assessed in terms of the social, economic and political obstacles to its implementation is the long term management phase. In this phase the disposal technology and institutional arrangements established will be tested over long periods of time.

It is simply not possible to make any predictions about the stability of the social fabric or social and political institutions for the length of time during which the wastes will remain hazardous. As a consequence, it may not be possible to design any system other than an engineered technical one for the protection of future generations. This does not, however, excuse consideration of the fundamental question: does the society have a right to impose so great and terrible a burden on future generations who will share none of the benefits of nuclear energy? A significant portion of the American public answers this in the negative. DOE's continuing failure to seriously address this issue is a clear indication of its lack of understanding of the social and political obstacles to the implementation of its program.

V. The DOE Program is Highly Likely to Result in an Inadequate and Unsafe Waste Disposal System.

The preceding sections of this statement amply demonstrate that the DOE program offers no basis for a finding confidence by the NRC that a safe waste disposal program will be in place before the expiration of current nuclear plant licenses. In fact, DOE's program is likely to result in an inadequate and unsafe waste disposal system. One major reason for this is DOE's failure to attack the problem in a rational way.

The most rational way to attack the radioactive waste disposal problem is to break it down into four successive and essential efforts.

- First, the waste disposal problem must be carefully defined, including the biological hazard posed by the wastes and the present and future logistic problems involved in its disposal.
- Second, a definitive set of waste disposal criteria must be established, the overriding objective of which is the protection of present and future generations from the adverse effects of exposure to the ionizing radiation associated with the wastes.
- Third, an R & D program must be established to identify the disposal approaches which would meet the criteria. As part of this R & D program, procedures and instrumentation must be developed and implemented to determine that the chosen disposal approaches and sites will meet the criteria.

- Fourth, sites must be selected based upon the R & D program and the waste disposal demonstration aspect begun to show that the selected sites satisfy the criteria.

If the waste problem is to be solved properly, the above approach must be followed. DOE, however, is proceeding backwards. The geologic media of choice -- salt -- and the site -- yesterday Lyons, Kansas, today near Carlsbad, New Mexico -- were chosen first, and now the Nuclear Regulatory Commission and the Environmental Protection Agency are being asked to develop the criteria for media and site selection.

Moreover, as California Energy Commissioner Varanini has noted:

> Currently the entire [radioactive waste] program is being driven by the DOE target for a licensed repository for initial operations by 1985. This schedule and the DOE program place NRC and EPA in a policy dilemma. Activities of EPA and NRC being done in parallel are better done sequentially. EPA is developing waste repository environmental standards which in turn are to form a basis for NRC site selection and suitability criteria. In fact, though, NRC may issue its criteria before EPA has finished its standards. This circumstance coupled with the lack of large-scale testing before standards are set means that these EPA and NRC standards will likely change dramatically over time. 108/

As a result of its backwards approach it is highly likely that the DOE Program will produce an inadequate and unsafe disposal system. DOE's backwards approach reflects the driving force which has shaped all of its recent radioactive waste

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108/ Emilio E. Varanini, Testimony before the Subcommittee on Nuclear Regulation, Senate Committee on Environment and Public Works on Nuclear Waste Management, Washington, D.C., April 4, 1978.

policy decisions. This driving force is not to find a safe disposal technology. Rather it is a desire within DOE to insure the survival of the commercial nuclear power option. Recent policy decisions have been little more than responses to the problems of the nuclear power industry.

From the perspective of the nuclear industry there are four clearly identifiable nuclear waste problems. First, there is the problem arising from the recent California nuclear laws which require some sort of demonstration that the waste problem is solvable. Second, public service and utility commissions (PSCs and PUCs) are demanding that nuclear fuel cycle uncertainties be reduced and that the cost of nuclear waste management be determined. Third, the utilities are becoming clogged with waste -- the spent fuel storage problem. And finally, the Congress and the public are clamoring that the DOE does not know what it is doing, -- that a workable process for solving the waste problem does not exist.

DOE's response to the California problem is the proposed demonstration effort at the WIPP facility. Although the geologic community, at least here in the U.S., has all but abandoned both salt and Carlsbad, DOE suggests that the determination of whether salt is an appropriate medium and Carlsbad an appropriate site be adjudicated via the NRC licensing process. Second, in response to the PSCs and PUCs, DOE is offering to take title to wastes for a fixed fee. Third, in response to the spent fuel storage problem, DOE has recommended away-from-reactor (AFR) storage. AFR storage, of course, goes hand in hand with the government taking title to the

fuel for a fixed fee. And lastly, in response to the criticism that the waste program is in shambles, the President has set in motion an interagency review of nuclear waste strategy. All but the last of these responses conflict with the approach required for a logical development of an adequate waste disposal system.

If the DOE continues to follow its present course, the conflict among objectives will increase, in large measure because a severe logistics problem looms ahead. 109/ The roughly 200 GWe of nuclear power already on the books -- that is, plants licensed, under construction, ordered or publicly announced -- will produce enough high-level radioactive waste to fill two repositories, if the DOE capacity figure of 100,000 tons of high level waste per 2000 acre repository is used, and six repositories, if the California Energy Commission figure of 35,000 tons/repository is relied upon. If we assume a nuclear commitment of 300 GWe by the year 2000 110/, these numbers increase to three and nine repositories respectively.

In arguing for a breeder reactor, some nuclear industry spokesmen apply the term "prudent planning base" to uranium resource estimates. If "prudent planning" were applied equally to waste repositories, DOE should be looking now for its ninth repository. Instead the first site has yet to be identified.

109/ See Thomas B. Cochran and Arthur R. Tamplin, "Nuclear Waste: Too Much Too Soon" NRDC, June 1, 1978.

110/ Some nuclear industry spokesmen, for example Floyd Culler, President of the Electric Power Research Institute, have argued that about 400 GWe by the year 2000 reflects a minimum growth figure for the nuclear industry to survive.

Although the third (by DOE estimates) or ninth (by California estimates) repository will actually not be required for several decades, this analysis illustrates that a potentially severe logistics problem is ahead and that the U.S. cannot afford another waste management failure.

The prospect of a severe logistics problem has already led policy makers to conclude that they must solve the radioactive waste problem in a hurry. This is an invitation to mistakes. Geologic media sites will be chosen hastily. Assumptions concerning long term integrity will be made in the absence of confirmatory data. Corners will be cut to meet unrealistic deadlines. There is real danger that the Federal Government, in the interest of salvaging nuclear power, will continue repeating the same mistakes that led to the controversies over reactor safety and nuclear weapons proliferation.

Not only is DOE proceeding backwards through the stages of developing a waste disposal program, it is receiving conflicting signals concerning the goals of this program which further undermine its likelihood of success. There are significant pressures on the Administration from the nuclear industry and the Congress to reverse the reprocessing decision and to allow reprocessing of spent fuel, recycle of plutonium and construction of the breeder reactor. Despite the President's policy on reprocessing, the industry continues to push for and Congress continues to appropriate funds for the Barnwell reprocessing facility and the CRBR. These institutional signals are producing at DOE less

than enthusiastic efforts to investigate the processes required for the disposal of spent fuel per se. In addition, because of the existence of military wastes, there are incentives to investigate the disposal of reprocessing wastes. As a consequence, there is good reason to suggest that solution of the problems associated with spent fuel disposal will be given less than total commitment. Less than total commitment in the context of a haphazard and backward program devoted mo- to preserving the nuclear option than to safe waste disposal is virtually certain to result in an inadequate and unsafe waste disposal solution.

VI. There is no Basis for Confidence Now Available That Radioactive Waste Can be Safely Stored On-Site Past the Expiration of Existing Operating Licenses Until Final Disposal is Possible.

The second major issue in this proceeding is whether radioactive spent fuel will be stored safely at reactor sites for an indefinite period of time beyond the expiration of existing operating licenses. The requirement that the Commission address this issue stems from the opinion of the Court of Appeals for the District of Columbia Circuit in State of Minnesota v. U.S. Nuclear Regulatory Commission, 602 F.2d 412 (D.C. Cir. 1979), in which the Nuclear Regulatory Commission was ordered to determine

> whether there is reasonable assurance that an off-site storage solution will be available by the years 2007-2009, the expiration of the plants' operating licenses, and if not, whether there is reasonable assurance that the fuel can be stored safely at the sites beyond those dates. (emphasis supplied) Id at 418.

As the previous section of this statement demonstrate, there is no basis for a finding of reasonable assurance that an off-site disposal solution will be available before operating licenses expire. Thus, the Commission must address the issue of indefinite on-site storage. If the Commission cannot determine that spent fuel will be stored safely at reactor sites for an indefinite period, it will be required to halt the continued production of spent fuel until a safe disposal solution is found.

The technical considerations involved in the safe indefinite storage of spent fuel are discussed in extensive, but largely irrelevant, detail in Part IV of the Department of Energy Statement of Position. These descriptions of technical components and precise radiation measurements obscure the fact that at least two fundamental

problems are not resolved. These problems, which are either ignored or treated very lightly by DOE, demonstrate that there can be no reasonable assurance of safe indefinite on-site storage, given the proposed approaches to and the existing state of knowledge about spent fuel storage.

First, all of the proposed on-site storage techniques under consideration involve some form of actively managed pool storage. Today all spent fuel is stored in water pools, and DOE clearly expects that to remain true for some time in the future. While DOE believes dry pools to be a feasible approach, it only suggests that they be given further review. There is no consideration given to conversion of on-site storage to dry pools. In any event, both wet and dry pools require continuous active management of the storage facility. 111/

As a result, all on-site storage is vulnerable to the hazards and uncertainties afflicting any program which depends upon human management. During the time period for which spent fuel pools will be in use before a permanent disposal solution is found, a small loss of coolant accident, if managed improperly, would spell disaster.

111/ This is also true of any away-from-reactor (AFR) interim storage facility that DOE might propose. DOE is currently looking at NSF-West Valley, GE-Morris, and AGNS-Barnwell as possible sites for a government AFR. All of these options involve pool storage. AFRs are subject to the same vulnerabilities and technical limitations as on-site storage. In any case, AFRs are only marginally relevant and cannot seriously be considered as a solution, both because DOE's policy is to maximize reliance on on-site storage, and because they do not provide the permanent disposal assurance that must be available before the nuclear power program may continue.

The hazards of management incompetence, or at least inattention, have been demonstrated at Three Mile Island and elsewhere. However, they do not represent the only human uncertainties that erode the basis for confidence in safe indefinite on-site storage. Any continuously managed facility is also subject to intentional harm by disruptive forces, from within American society or elsewhere. A terrorist attack on facility operators would pose a serious hazard, and there is no way to assure that an attack will not occur within the indefinite period for which the fuel will have to be stored.

Although these examples of hazards to a managed facility raise serious questions about the ability of DOE to guarantee reasonable safety of pool storage for long periods, mitigation efforts could provide some degree of protection. A far more serious problem is the potential loss of integrity of the social fabric. On a large scale, war or political disintegration would threaten any program of active management of a spent fuel storage facility. Although the prospect of war is not at all attractive, history dictates that it must be considered likely within a relatively short time, i.e., less then a century. The same is true of the disintegration of political institutions, although the time frame for analysis may be somewhat longer. In either case, the fact that spent fuel pools will have to be managed in order to remain safe renders them unacceptable as indefinite storage solutions.

On a smaller, and more immediate scale, the abandonment of

the nuclear fuel dump at West Valley, New York demonstrates there is little or no assurance that regulatory authority can guarantee proper management of spent fuel. There is no way to force a company to stay in business. If a utility gives up on a facility, as Getty Oil did at West Valley, the spent fuel may be left unmanaged. Similarly, spent fuel pools may be abandoned if a utility goes bankrupt, as may well be the case with Metropolitan Edison, the owner of Three Mile Island.

Given the hazards inherent in any actively managed spent fuel storage system, there is general agreement that a long-term solution must involve a "passive" design which does not require monitoring and management to assure safety. Indeed, DOE has adopted a major criterion on this point as a basis for judging the acceptability of a disposal facility:

> Acceptable performance should be based on methods reasonably available and should not depend upon continued maintenance or surveillance for unreasonable times into the future. 112/

DOE violates its own standard by arguing that spent fuel pool storage will be an adequate long-term "interim" solution until a permanent disposal solution is found at some unknown point in the future.

The second major issue that demonstrates the Commission cannot find a reasonable assurance of safe indefinite on-site storage is the lack of sufficient data to establish that spent fuel can be stored safely for periods well in excess of 40 years. According to DOE's own information, zincalloy clad spent fuel

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112/ DOE Statement of Position, p. I-14.

has only been stored for 21 years and stainless steel clad fuel for 12 years. 113/This is hardly an adequate data base for a finding of "reasonable assurance" of safety for the indefinite future.

The lack of data on the performance of spent fuel in storage led to the following conclusions by the Honorable Mr. Justice Parker in the Windscale Inquiry in Great Britain in 1978:

> a. It is probable that zircaloy fuel may be stored for up to 20 years, and remain suitable for handling and reprocessing.
>
> b. It would be imprudent to store substantial quantities of stainless steel clad fuel in ponds for more than a decade.

In his own words, Mr. Justice Parker concluded, that

> [long-term spent fuel storage] is not prudent with existing design methods I have no doubt.

Given the existing data establish that spent fuel can be stored successfully only for a period equal to half of the term of an operating license, the most the Commission can find at this point is that spent fuel can be stored safely on-site for relatively short periods during which events are reasonably foreseeable. To attempt to go beyond that point is to lapse from extrapolation into speculation.

Precisely the same issues arise with any attempt to solve the storage problem with Away From Reactor (AFR) facilities. AFRs will use either the same technology as reactor storage pools, or they will use an untried dry storage technology. In

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113/ Id, Table IV-13.

either case, they will be subject to the same hazards and uncertainties as reactor storage pools. Since AFR storage does not provide the requisite "reasonable assurance," that spent fuel will not pose a hazard to the public, it cannot be considered an alternative to permanent disposal, or to a demonstration that safe on-site storage can be assured. In other words, an AFR does not resolve the basic issue involved in this proceeding. If neither permanent disposal nor indefinite on-site storage can be shown to be reasonably safe and available within the requisite time period, the AFR approach is simply gambling once more with the public health. In the words of Judge Tamm, cited in State of Minnesota v. U.S.N.R.C., 602 F.2d at 417, N. 6, relying on AFRs in the absence of any real answers would be a

> reckless decision to mortgage the future for the present, glibly assuring critics that technological advancement can be counted upon to save us from the consequences of our decisions.

The purpose of the Atomic Energy Act, the National Environmental Policy Act, and the State of Minnesota decision is to assure that the Nuclear Regulatory Commission does not mortgage the future to the nuclear pawnbroker. The NRC may not do so with AFRs any more than it may do so with on-site spent fuel pools.

In summary, there is no reasonable assurance that safe storage will be available for an indefinite period beyond the expiration of current operating licenses. The most that can be said in that spent fuel apparently can be stored safely on-site for short periods, perhaps until current licenses expire. To say

Conclusion

No aspect of the DOE program provides reasonable assurance to the NRC that a safe, reliable off-site waste disposal system will be available and operational before the expiration of current nuclear facility licenses. The NRC cannot find that it has the requisite degree of confidence that wastes will be safely disposed of off-site. Nor can it find that it has confidence that wastes can and will be retained safely on-site until off-site disposal is available.

Respectfully submitted,

Karin P. Sheldon

Karin P. Sheldon
William S. Jordan, III
Lee Bishop
Sheldon, Harmon & Weiss
1725 I Street, N.W.
Washington, D.C. 20006

Dr. Thomas Cochran
Dr. Arthur Tamplin
Dr. Terry A. Lash
Ms. Georgia Yuan
Natural Resources Defense Council
1725 I Street, N.W.
Washington, D.C. 20006