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MEMORANDUM TO: All Division of High-Level Waste Management Staff

FROM: Robert E. Browning, Director
Division of High-Level Waste Management

SUBJECT: WASTE CONFIDENCE DECISION REVIEW

Enclosed for your information is the Final Review of the Waste Confidence Decision as it appeared in the September 18, 1990 Federal Register.

RE Browning
Robert E. Browning, Director
Division of HIgh-Level Waste Management

Enclosure:
As stated

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Part III

Nuclear Regulatory Commission

10 CFR Part 51

Consideration of Environmental Impacts of Temporary Storage of Spent Fuel After Cessation of Reactor Operation; and Waste Confidence Decision Review; Final Rules

NUCLEAR REGULATORY COMMISSION

10 CFR Part 51

RIN 3150-AD26

Consideration of Environmental Impacts of Temporary Storage of Spent Fuel After Cessation of Reactor Operation

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

SUMMARY: The Nuclear Regulatory Commission is revising its generic determinations on the timing of availability of a geologic repository for commercial high-level radioactive waste and spent fuel and the environmental impacts of storage of spent fuel at reactor sites after the expiration of reactor operating licenses. These revisions reflect findings of the Commission reached in a five-year update and supplement to its 1984 "Waste Confidence" rulemaking proceeding, which are published elsewhere in this issue of the Federal Register. The Commission now finds that spent fuel generated in any reactor can be stored safely and without significant environmental impacts in reactor facility storage pools or independent spent fuel storage installations located at reactor or away-from-reactor sites for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license). Further, the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time.

EFFECTIVE DATE: October 18, 1990.

FOR FURTHER INFORMATION CONTACT: John P. Roberts, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone: (301) 492-0608.

SUPPLEMENTARY INFORMATION:

Background

In 1984, the Commission concluded a generic rulemaking proceeding, the "Waste Confidence" 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 would be available, and whether such wastes can be safely stored until they are safely disposed of. The Commission found that there was reasonable assurance that one or more mined geologic repositories for commercial high-level radioactive waste and spent fuel will be available by 2007-2009. However, some reactor operating licenses might expire without being renewed or some reactors might be permanently shut down prior to this period. Since independent spent fuel storage installations had not yet been extensively developed, there was a probability that some onsite spent fuel storage after license expiration might be necessary or appropriate. In addition, the possibility existed that spent fuel might be stored in existing or new storage facilities for some period beyond 2007-2009. The Commission also found that the licensed storage of spent fuel for at least 30 years beyond the reactor operating license expiration either at or away from the reactor site was feasible, safe, and would not result in a significant impact on the environment.

Consequently, the Commission adopted a rule, codified in 10 CFR 51.23, providing that the environmental impacts of at-reactor storage after the termination of reactor operating licenses need not be considered in Commission proceedings related to issuance or amendment of a reactor operating license. The same safety and environmental considerations applied to fuel storage installations licensed under part 72 as for storage in reactor basins. Accordingly, the rule also provided that the environmental impacts of spent fuel storage at independent spent fuel storage installations for the period following expiration of the installation storage license or amendment need not be considered in proceedings related to issuance or amendment of a storage installation license.

Amendment to Part 51

At the time of issuance of its Waste Confidence decision and the adoption of 10 CFR 51.23, the Commission also announced that while it believed that it could, with reasonable assurance, reach favorable conclusions of confidence, it also recognized that significant unexpected events might affect its decision.

Consequently, the Commission stated that it would "review its conclusions on waste confidence should significant and pertinent unexpected events occur, or at least every 5 years until a repository for high-level radioactive waste and spent fuel is available." The Commission has now completed a five-year review of its earlier findings. A description of this review and the supplement and update to the earlier findings is announced elsewhere in this issue. As a result of this review, the Commission is modifying two of its earlier findings as follows:

The Commission finds reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time; and

The Commission finds reasonable assurance that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin, or at either onsite or offsite independent spent fuel storage installations.

In this proceeding, the Commission is revising 10 CFR 51.23(a) to be consistent with these revisions to the Waste Confidence decision.

Summary of Comments

The Commission received 11 comments on its proposed revision to 10 CFR 51.23(a) from the following entities listed in the order of receipt of comments:

Duke Power Company
Public Citizen
Edison Electric Institute
Malachy Murphy (State of Nevada)
Yankee Atomic Electric Company
Department of Energy (DOE)
Philadelphia Electric Company
Commonwealth Edison
Virginia Electric and Power Company
Marvin I. Lewis, Registered Professional Engineer
Florida Power & Light

The revision to this rule was supported by Duke Power Company, Edison Electric Institute, Yankee Atomic Electric Company, Department of Energy, Philadelphia Electric Company, and Virginia Electric and Power Company and generally supported by Commonwealth Edison.

Malachy Murphy, for the State of Nevada, suggests that 10 CFR 51.23(a) be amended to reflect reasonable assurance that spent fuel can be stored safely and without significant environmental risk in dry casks at reactor sites for up to one hundred years. The Commission, in the notice of proposed rulemaking, discussed its conclusion that even if storage of spent fuel were necessary for at least thirty

years beyond the licensed life for operation of reactors, which for a reactor whose license is renewed for thirty years would mean a period of at least 100 years, such storage is feasible, safe and would not result in a significant impact on the environment. The Commission's conclusion on this issue considers both wet and dry storage. Although the Commission does not dispute the statement that dry spent fuel storage is safe and environmentally acceptable for a period of 100 years, the Commission does not find it necessary to make that specific finding in this proceeding.

Marvin I. Lewis avers that 100 years is an excessive amount of time to predict that at-reactor storage will be available and safe. The commenter suggests that our institutions may not survive in a form that will provide safe onsite storage 100 years in the future. The commenter requests that the Commission reverse its finding that storage will be available and safe for 100 years. The Commission does not agree with the commenter that this finding should be reversed. The Commission believes that adequate regulatory authority exists and will remain available to require any measures necessary to assure safe storage of spent fuel.

Conclusions

The Commission is adopting the proposed revision with one small clarifying change. The proposed revision to 10 CFR 51.23(a) (and the proposed revision to the Waste Confidence decision) stated that spent fuel can be stored safely for at least 30 years beyond the licensed life for operation of any reactor which may include the term of a "revised license." As the discussion in the notice made explicit, the term "revised" license was intended to embrace a "renewed" license. To reflect more accurately the inclusion of the term of a renewed license, the parenthetical phrase which refers to this subject is being revised to read: "which may include the term of a revised or renewed license."

The necessity for the proposed revisions to the Waste Confidence decision and to 10 CFR 51.23(a) is based on the timing of repository availability, and premised on the following factors: The potential for delays in DOE's program; the mandate of the Nuclear Waste Policy Act Amendments of 1987 to characterize only the Yucca Mountain site which means that if that site is found unsuitable, characterization will have to begin at another site or suite of sites with consequent delay in repository availability; the regulatory need to avoid premature commitment to the Yucca Mountain site; and the questionable value of making predictions about completion of a project as complex and unique as the repository in terms of years when decades would be more realistic. But even with this change the Commission has concluded that it has reasonable assurance that on such a schedule for repository availability, sufficient repository capacity will be available within 30 years beyond the licensed life for operation of reactors. Adequate regulatory authority is available to require any measures necessary to assure safe storage of the spent fuel until a repository is available. In addition, the Commission has concluded that even if storage of spent fuel were necessary for at least 30 years beyond the licensed life of reactors, which in the case of a reactor whose operating license is renewed for 30 years would mean for a period of at least 100 years, such storage is feasible, safe and would not result in a significant impact on the environment.

The Commission's conclusions with respect to safety and environmental impacts of extended storage are supported by NRC's Environmental Assessment (EA) for the 10 CFR part 72 rulemaking "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste" (53 FR 31651, August 19, 1988). Ongoing licensing and operational experience as well as studies of extended pool storage continue to demonstrate that such storage is a benign environment for spent fuel which does not lead to significant degradation of spent fuel integrity. Significant advances in the processes of dry storage of spent fuel continue to demonstrate that dry storage systems are simple, passive and easily maintained. NRC staff safety reviews of topical reports on dry storage system designs and dry storage installations at two reactor sites, as well as the EA for part 72, support the finding that storage of spent fuel in such installations for a period of 70 years does not significantly impact the environment. No significant additional non-radiological consequences which could adversely effect the environment for extended storage at reactors and independent spent fuel storage installations have been identified. In sum, the long-term material and system degradation effects are well understood and known to be minor, the ability to maintain a spent fuel storage system is assured, and the Commission maintains regulatory authority over any spent fuel storage installation.

Environmental Impact

This final rule amends 10 CFR part 51 of the Commission's regulations to modify the generic determination currently codified in part 51 which was made by the Commission in the Waste Confidence rulemaking proceeding. That generic determination was that for at least 30 years beyond the expiration of a reactor's operating license no significant environmental impacts will result from the storage of spent fuel in reactor facility storage pool or independent spent fuel storage installations located at reactor or away-from-reactor sites. The modification provides that, if necessary, spent fuel generated in a reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation of any reactor. The licensed life for operation of a reactor may include the term of a revised or renewed license. The environmental analysis on which the revised generic determination is based can be found in the revision and supplement to the Waste Confidence findings published elsewhere in this issue. This final rulemaking action formally incorporating the revised generic determination in the Commission's regulations does not have separate independent environmental impact. The supplemental assessment and revisions to the Waste Confidence findings are available for inspection at the NRC Public Document Room, 2120 L Street, NW. (Lower Level), Washington, DC.

Paperwork Reduction Act Statement

This final rule does not contain a new or amended information collection requirement subject to the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 *et seq.*). Existing requirements were approved by the Office of Management and Budget approval number 3150-0021.

Regulatory Flexibility Certification

As required by the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission certifies that this rule will not have a significant economic impact on a substantial number of small entities. The rule describes a revised basis for continuing in effect the current provisions of 10 CFR 51.23(b) which provides that no discussion of any environmental impact of spent fuel storage in reactor facility storage pools or independent spent fuel storage installations [ISFSI] for the period following the term of the reactor operating license or amendment or

initial ISFSI license or amendment for which application is made is required in any environmental report, environmental impact statement, environmental assessment or other analysis prepared in connection with certain actions. This rule affects only the licensing and operation of nuclear power plants. Entities seeking or holding Commission licenses for such facilities do not fall within the scope of the definition of small businesses found in section 34 of the Small Business Act, 15 U.S.C. 632, in the Small Business Size Standards set out in regulations issued by the Small Business Administration at 13 CFR part 121, or in the NRC's size standards published December 9, 1985 (50 FR 50241).

Backfit Analysis

This final rule does not modify or add to systems, structures, components or design of a facility; the design approval or manufacturing license for a facility; or the procedures or organization required to design, construct or operate a facility. Accordingly, no backfit analysis pursuant to 10 CFR 50.109(c) is required for this final rule.

List of Subjects in 10 CFR Part 51

Administration practice and procedure, Environmental impact statement, Nuclear materials, Nuclear power plants and reactors, Reporting and recordkeeping requirements.

For the reasons set out in the preamble and under the authority of the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and 5 U.S.C. 552 and 553, the NRC is adopting the following amendment to 10 CFR part 51.

PART 51—ENVIRONMENTAL PROTECTION REGULATIONS FOR DOMESTIC LICENSING AND RELATED REGULATORY FUNCTIONS

1. The authority citation for part 51 continues to read as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201); secs. 201, as amended, 202, 88 Stat. 1242, as amended, 1244 (42 U.S.C. 5841, 5842).

Subpart A also issued under National Environmental Policy Act of 1969, secs. 102, 104, 105, 83 Stat. 853-854, as amended (42 U.S.C. 4332, 4334, 4335); and Pub. L. 95-604, Title II, 92 Stat. 3033-3041. Sections 51.20, 51.30, 51.60, 51.61, 51.80, and 51.97 also issued under secs. 135, 141, Pub. L. 97-425, 96 Stat. 2232, 2241, and sec. 148, Pub. L. 100-203, 101 Stat. 1330-223 (42 U.S.C. 10155, 10161, 10168). Section 51.22 also issued under sec. 274, 73 Stat. 688, as amended by 92 Stat. 3036-3038 (42 U.S.C. 2021) and under Nuclear Waste Policy Act of 1982, sec. 121, 96 Stat. 2228 (42 U.S.C. 10141). Sections 51.43, 51.67, and 51.109 also issued under Nuclear Waste Policy Act of 1982, sec. 114(f), 96 Stat. 2216, as amended (42 U.S.C. 10134(f)).

2. Section 51.23, paragraph (a) is revised to read as follows:

§ 51.23 Temporary storage of spent fuel after cessation of reactor operation—generic determination of no significant environmental impact.

(a) The Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installations. Further, the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time.

* * * * *

Dated at Rockville, Maryland this 11th day of September, 1990.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,

Secretary of the Commission.

[FR Doc. 90-21689 Filed 9-17-90; 8:45 a.m.]

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10 CFR Part 51

Waste Confidence Decision Review

AGENCY: Nuclear Regulatory Commission.

ACTION: Review and Final Revision of Waste Confidence Decision.

SUMMARY: On August 31, 1984, the Nuclear Regulatory Commission (NRC) issued a final decision on what has come to be known as its "Waste Confidence Proceeding." The purpose of that proceeding was "...to assess generically the degree of assurance now available that radioactive waste can be safely disposed of, to determine when such disposal or offsite storage will be available and to determine whether radioactive waste can be safely stored onsite past the expiration of existing facility licenses until offsite disposal or storage is available." (49 FR 34658). The Commission noted in 1984 that its Waste Confidence Decision was unavoidably in the nature of a prediction, and committed to review its conclusions "...should significant and pertinent unexpected events occur or at least every five years until a repository is available." The purpose of this notice is to present the findings of the Commission's first review of that Decision.

The Commission has reviewed its five findings and the rationale for them in light of developments since 1984. This revised Waste Confidence Decision supplements those 1984 findings and the environmental analysis supporting them. The Commission is revising the second and fourth findings in the Waste Confidence Decision as follows:

Finding 2: The Commission finds reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and that sufficient repository capacity will be available within 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of any reactor to dispose of the commercial high-level radioactive waste and spent fuel originating in such reactor and generated up to that time.

Finding 4: The Commission finds reasonable assurance that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin, or at either onsite or offsite independent spent fuel storage installations.

The Commission is reaffirming the remaining findings. Each finding, any revisions, and the reasons for revising or reaffirming them are set forth in the body of the review below.

The Commission also issued two companion rulemaking amendments at the time it issued the 1984 Waste Confidence Decision. The Commission's reactor licensing rule, 10 CFR part 50, was amended to require each licensed reactor operator to submit, no later than five years before expiration of the operating license, plans for managing spent fuel at the reactor site until the spent fuel is transferred to the Department of Energy (DOE) for disposal under the Nuclear Waste Policy Act of 1982 (NWPA). 10 CFR part 51, the rule defining NRC's responsibilities under the National Environmental Policy Act (NEPA), was amended to provide that, in connection with the issuance or amendment of a reactor operating license or initial license for an independent spent fuel storage installation, no discussion of any

environmental impact of spent fuel storage is required for the period following expiration of the license or amendment applied for.

In keeping with the revised Findings 2 and 4, the Commission is providing elsewhere in this issue of the Federal Register conforming amendments to its 10 CFR part 51 rule providing procedures for considering in licensing proceedings the environmental effects of extended onsite storage of spent fuel.

Finally, the Commission is extending the cycle of its Waste Confidence reviews from every five years to every ten until a repository becomes available. In its 1984 Decision, the Commission said that because its conclusions were "...unavoidably in the nature of a prediction," it would review them "...should significant and pertinent unexpected events occur, or at least every five years until a repository...is available." As noted below, the Commission now believes that predictions of repository availability are best expressed in terms of decades rather than years. To specify a year for the expected availability of a repository decades hence would misleadingly imply a degree of precision now unattainable. Accordingly, the Commission is changing its original commitment in order to review its Waste Confidence Decision at least every ten years. This would not, however, disturb the Commission's original commitment to review its Decision whenever significant and pertinent unexpected events occur. The Commission anticipates that such events as a major shift in national policy, a major unexpected institutional development, and/or new technical information might cause the Commission to consider reevaluating its Waste Confidence Findings sooner than the scheduled ten-year review.

FOR FURTHER INFORMATION CONTACT: John Roberts, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (202) 492-0608.

SUPPLEMENTARY INFORMATION:

Analysis of Public Comments on the Proposed Waste Confidence Decision Review.

1.0 Introduction

Comments were received from a Federal agency, the public interest sector, the nuclear industry, and one State as listed below in order of their receipt:

Duke Power Company
Public Citizen
Edison Electric Institute
Malachy Murphy (State of Nevada)
Yankee Atomic Electric Company
Department of Energy
Philadelphia Electric Company
Commonwealth Edison
Virginia Electric and Power Company
Marvin I. Lewis, Registered Professional Engineer
Florida Power & Light Company

The majority of the commenters were supportive of the Commission's proposed decision and rule. The comments were consolidated into a total of 19 issues to be addressed. Each of these issues is discussed under the Commission finding to which it relates. Two additional issues, not raised by commenters, are treated under the heading "Other Relevant Issues." The "Other Relevant Issues" section includes consideration of the petition by the State of Vermont to intervene in the consideration of the extension of the operating license for Vermont Yankee and the potential for non-payment of the one-time fee for spent nuclear fuel generated prior to April 1983 into the Nuclear Waste Fund.

2.0 Analysis of Issues Related to Commission Findings

2.1 The Commission's First Finding

The Commission finds reasonable assurance that safe disposal of high-level radioactive waste and spent fuel in a mined geologic repository is technically feasible.

Issue No. 1: Technical Feasibility of Safe Disposal in a Mined Geologic Repository

Comment

The commenter representing Public Citizen (PC) stated that there is still not adequate assurance that permanent, safe disposal of high-level radioactive waste in a mined geologic repository is technically feasible. In support of this, the commenter indicated that a number of major scientific panels have pointed out that there is no technical or scientific basis for knowing for sure that geologic disposal is possible. As an example, PC stated that President Carter's Office of Science and Technology Policy (OSTP) found in 1979 a rather general consensus among scientists that a technology base "sufficient to permit complete confidence in the safety of any particular repository design or the suitability of any particular site" was still lacking. PC further stated that more recently, a Waste Isolation Systems Panel of the National Academy of Sciences pointed out many areas of the geologic disposal problem where technical uncertainties exist, and where "more information is needed." PC also stated that the technical difficulties presented by a million-year disposal problem are unprecedented and enormous, and that there have been no major findings since (the above studies) that have resolved the uncertainties to the point where it is possible to be *assured* that geologic disposal is technically feasible.

NRC Response

The issue of the technical feasibility of the safe disposal of spent nuclear fuel and radioactive waste has been addressed at length in the Commission's 1989 Proposed Waste Confidence Decision Review (54 FR 39767; September 28, 1989) as well as in the original 1984 Waste Confidence Decision (49 FR 34658; August 31, 1984). While those discussions addressed the concerns raised by the comment, it is useful to provide additional specific responses to them. The comment that major scientific panels have pointed out that there is no technical or scientific basis for knowing for sure that geologic disposal is possible makes reference to President Carter's OSTP statement in 1979. Contrary to the comment, the OSTP statement does not support the contention that there is no technical or scientific basis for knowing for sure that geologic disposal is possible. Rather, it remarks on the lack of a technology base sufficient to permit complete confidence in the safety of any particular repository design or the suitability of any particular site. The information base necessary to license a repository is still being developed. This includes information on site characterization, repository design, waste package design, and the performance assessment of the entire disposal system. The complete body of such necessary information is expected to be in hand only at the completion of the developmental studies and characterization work being undertaken by the DOE. It is at this point that the DOE will be in a position to apply for a license from the NRC and seek NRC's approval of the safety of its proposed site and repository design.

The Commission also notes that the OSTP statement was made over a decade ago, prior to the completion of a substantial amount of work which has addressed many of the issues related to disposal technology. While the Commission recognizes that more information is needed and that the technical difficulties are challenging, there is no basis to believe that safe disposal in a repository is impossible, or even that it is not likely. No major breakthrough in technology is required to develop a mined geologic repository. Rather, there is a need to add to the current extensive body of technical

information already available and apply it to an evaluation of specific sites and engineering designs.

Regarding the commenter's emphasis on the need for resolution of uncertainties to assure the technical feasibility of geologic disposal, we would respond that the Commission did not state that the feasibility of a mined geologic repository was assured, in the absolute sense, but that it had found reasonable assurance in the feasibility of mined geologic disposal on the basis of a thorough review of the technologies needed to achieve this disposal.

Issue No. 2: Difficulty in Evaluating Compliance with Repository Safety Standards Over Long Time Periods

Comment

The PC commenter also raised the issue of what he termed the "inability to predict with a reasonable degree of certainty that, once buried, the waste will remain contained [in the geologic repository] for the required time period." The commenter noted uncertainties related to geologic stability, engineered barriers, rock-waste interactions, and groundwater hydrology which contribute to the difficulty of evaluating compliance with safety standards over the long time periods involved in radioactive waste isolation. The commenter concluded that although these problems may be able to be resolved, there is not a basis for assurance that this will be the case.

NRC Response

The NRC believes that existing safety assessment techniques have the potential to provide a basis for deciding whether proposed radioactive waste disposal systems are acceptable. We recognize the difficulty of predicting with a high degree of accuracy the maximum impacts a repository would have on human health and the environment, especially in the very far future. It will likely not be possible to test empirically the ability of models to predict long-term repository performance to the same extent as models for short-term performance. However, we believe existing technology can provide a sufficient level of safety for present and future generations under certain conditions. These conditions include addressing the uncertainties inherent in projecting far into the future and in modelling complex heterogeneous natural systems, and acquiring and evaluating data on specific sites.

We also note that the language of the original Environmental Protection Agency's (EPA) Environmental Radiation Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Wastes (40 CFR part 191) does not require absolute assurance that containment requirements will be met. Rather, it recognizes the uncertainties involved in projecting repository performance far into the future, and states "Instead, what is required is a reasonable expectation, on the basis of the record before the implementing agency, that compliance with Sec.191.13(a) will be achieved."

Issue No. 3: Unanticipated Difficulties in Developing the WIPP Facility

Comment

PC also indicated that the Waste Isolation Pilot Plant (WIPP) has not opened because of numerous unanticipated difficulties, including leakage of salt water into the site. PC states that this leakage, which was not anticipated prior to the beginning of construction in the early 1980s, shows that even on a scale of a few years, geologic events in a repository are unpredictable--to say nothing of events on a time scale of hundreds of thousands of years.

NRC Response

Although the NRC does not have oversight responsibility for the WIPP project, NRC does monitor DOE progress on WIPP insofar as it may offer valuable insight into efforts to license a repository for commercial high-level waste and spent fuel. For example, DOE must demonstrate compliance with the EPA standard in order to operate the WIPP facility. NRC cognizance of DOE efforts to implement the EPA Standard at WIPP could help provide information and consensus-building in the implementation of the EPA Standard for the commercial high-level waste repository.

The NRC does not consider the occurrence of brine pockets at the WIPP site as a factor that might diminish its confidence in the technical feasibility of a mined geologic repository. The Commission does not expect that site characterization of a candidate site will proceed free from all difficulty. We have urged DOE to establish a planning mechanism for timely development and implementation of contingency plans at Yucca Mountain to address problems during site characterization as they arise. DOE has announced a new focus on surface-based testing for the Yucca Mountain site in its Reassessment Report to Congress. Under this program, the primary goal of testing is to identify features of the site which would render it unsuitable for a repository. If such features are identified, DOE would notify Congress and the State of Nevada, and terminate site specific activities. A finding that the Yucca Mountain site is unsuitable would likely lead to delays in repository availability while another candidate site is identified and characterized, however it would not diminish confidence in the technical feasibility of geologic disposal.

Issue No. 4: Impact of the BEIR V Report on the Commission's Decision

Comment

Marvin Lewis drew attention to the recent findings of the Committee on the Biological Effects of Ionizing Radiation (BEIR V) in their report on the Health Effects of Exposure to Low Levels of Ionizing Radiation. The commenter stated that the BEIR V study indicated that the danger from radioactivity is four or more times higher than previously known. The commenter further stated that the BEIR V findings will require that the NRC change many of its radiation protection guidelines and rules. He also requested that the NRC stop all action on the Waste Confidence Decision Review until the Commission can determine the effect of the BEIR V report on the Decision.

NRC Response

The Commission has been aware for some time of the scientific data underpinning the estimate of risk from radiation exposure contained in the BEIR V report. Much of this information has been incorporated in the Commission's forthcoming revisions to its radiation protection requirements (10 CFR part 20). For reasons stated below, however, the Commission does not foresee any impact of the BEIR V report on the Waste Confidence Decision.

The BEIR V report is the latest in a series of reports dealing principally with the effects of low-LET radiation in humans, e.g., radiation such as beta particles and gamma photons. The report covers radiation carcinogenesis, genetic effects, and effects on the developing embryo/fetus. The report also includes new information related to the dosimetry of the Japanese atomic bomb survivors, and new epidemiological information. The NRC staff, other Federal agencies, and national and international organizations are currently reviewing both the BEIR V report and the report issued in 1986 by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

The estimates of risk due to low-LET radiation in the BEIR V report are based principally upon effects observed in populations exposed to high doses and at high dose rates. These effects are then extrapolated using statistical modeling to predict effects at low doses

and dose rates. The extrapolations to low dose and dose rate lead to significant uncertainties in the estimates of risk in the BEIR V report. The estimates of risk for fatal cancer induction in the BEIR V report are from three to four times larger than the estimate from the preferred model of the BEIR III report in 1980. However, the new BEIR V estimate is within the overall range of risk estimates and uncertainties from the different models presented in BEIR III.

It is important to note that the BEIR V report only addresses the issue of risk estimates for radiation effects. The BEIR committee did not make any recommendations on acceptable risk or on the potential impacts of the risk estimates to dose limits or standards for radiation protection. Efforts are underway by the International Commission on Radiological Protection (ICRP), National Council on Radiation Protection and Measurements (NCRP), and the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC) of the Executive Office of the President to reach some measure of consensus on the impacts of the revised risk estimates to radiation protection standards.

Under section 121(a) of the Nuclear Waste Policy Act (NWPA), NRC is required to issue technical requirements and criteria that it will apply in approving or disapproving a repository. These requirements and criteria must be consistent with the high-level waste disposal standards promulgated by the Environmental Protection Agency. Demonstration of compliance with the EPA standard was discussed under the rationale for Finding 1 in the Commission's Proposed Waste Confidence Decision Review.

The NRC does not believe that numerical criteria for individual protection requirements are at issue in its Waste Confidence Proceeding. The broader issue of demonstrating compliance with EPA release limits using probabilistic analyses was a concern of the NRC staff and the NRC's Advisory Committee on Nuclear Waste in preparing the Proposed Waste Confidence Decision Review. As stated in the Proposed Waste Confidence Decision Review, the NRC staff is closely monitoring EPA's progress on issuing its revised standards to assure that EPA methodologies for demonstrating compliance with them can be applied by NRC to evaluate DOE's demonstration of compliance. NRC will also monitor DOE efforts to demonstrate compliance with the EPA standard at the Waste Isolation Pilot Plant facility for transuranic wastes.

2.2 The Commission's Second Finding

The Commission finds reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and that sufficient repository capacity will be available within 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of any reactor to dispose of the commercial high-level radioactive waste and spent fuel originating in such reactor and generated up to that time.

Issue No. 5: Expected Date for Repository Availability

Comment

Malachy Murphy (State of Nevada) and Public Citizen expressed a lack of support for the Commission's proposed second finding. These commenters argue that the finding should be revised to reflect the 2010 date for repository availability announced in DOE's November 1989 Reassessment Report to Congress. They believe that the NRC's "confidence" date of 2025 for repository availability may be exceeded if the Yucca Mountain site is found to be unsuitable sometime after the year 2000 because there might not be enough time to locate, characterize, license and construct a repository at another site by 2025. The commenter from Public Citizen also finds that even if the Yucca Mountain site were found to be suitable, a repository there might not be available until after 2025. This commenter concluded that it would be more conservative to assume that four candidate sites would be found to be unsuitable during the course of site characterization and that there is no basis for assurance that a repository would be available before 2055.

NRC Response

The NRC does not believe it is necessary to change the proposed second finding to reflect DOE's revised date for repository availability of 2010. NRC anticipated an extension of several years in DOE's schedule when it issued its proposed revised second finding. NRC took the position that if the Yucca Mountain site were found to be unsuitable on or before the year 2000, it was reasonable to expect that an alternative site could be identified and developed in time for repository availability by 2025.

NRC continues to believe that if DOE determines that the Yucca Mountain site is unsuitable, it will make this determination by about the year 2000. DOE's program is now focused on surface-based testing designed to identify features of the site which would render it unsuitable for a repository. The only significant barriers to DOE proceeding with site characterization at Yucca Mountain are the development of a quality assurance (QA) program acceptable to NRC, completion of study plans for site characterization activities they wish to begin, and resolution of the impasse between DOE and the State of Nevada regarding permits for drilling. DOE has made significant progress in the development of a QA program for its site characterization activities. It is possible that this work will be completed and accepted by late 1990 or early 1991. Regarding the impasse with the State of Nevada, both DOE and the State of Nevada have filed lawsuits in Federal Court in an effort to resolve the question of site access. While any litigation of this matter has the possibility of an unfavorable outcome for DOE, the Commission believes that Congress has aggressively demonstrated in both the Nuclear Waste Policy Act of 1982 and the Nuclear Waste Policy Amendments Act of 1987 that it is committed to an orderly progression of the repository program and a resolution of the radioactive waste disposal problem. Accordingly, NRC believes that it is reasonable to assume that Congress will not allow the uncertainties related to the start of site characterization to continue for many more years.

For these reasons, NRC believes that the coming decade will be ample time for the DOE to determine whether or not Yucca Mountain is unsuitable and to begin work on an alternate site, if necessary. We believe that Congress is committed to a resolution of the waste problem and will take measures to bring this issue to a close.

We would also point out here that the Court decision that led to the Waste Confidence Proceeding did not require NRC to determine when a repository would be available. The Court remanded to NRC the question of "...whether there is reasonable assurance that an offsite storage solution will be available by the years 2007-2009, the expiration of [Prairie Island and Vermont Yankee's] operating licenses, and if not, whether there is reasonable assurance that the fuel can be safely stored at the reactor sites beyond those dates." NRC chose as a matter of policy not to confine itself to the storage-related questions in the Court's remand, but to address the broader issues of whether radioactive wastes could be safely disposed of, when such disposal would be available, and whether such wastes can be safely stored until they are disposed of. NRC

determine nor has ... made a determination that a repository must be available by 2025 in order to protec[illegible]lic health and safety.

NRC does no[illegible]d a reasonable basis for the argument that even if the Yucca Mountain site were found to be suitable, it might not be available by the year 2025. Surface-based and in-situ testing are expected to take approximately ten years. The NWPA provides that NRC's review of DOE's license application is to be completed in three years (with the possibility of an additional year). Construction is scheduled to take another six years. Even if each of these activities were to take several years longer than planned, a repository at Yucca Mountain could be available well before the year 2025. The limiting condition appears to be the timing of DOE's access to the site to begin testing.

Finally, we do not believe it is realistic to assume for conservatism that four candidate sites will be found unsuitable before an acceptable site is characterized, licensed and built. To date, no candidate site for a repository has been found to be unsuitable for technical reasons. However, if the Yucca Mountain site is found to be unsuitable, an alternative site would have to undergo a similar process of site-screening and characterization to determine its suitability. We believe it is reasonable to expect that experience gained in the Yucca Mountain site characterization effort would provide a better basis for choosing an alternative site. Furthermore, it may be possible to complete site suitability testing at another site at a faster pace than at Yucca Mountain given the benefits of lessons-learned at that site.

Issue No. 6: Clarification of the NRC's Role in the Licensing Support System (LSS)

Comment

The DOE commented that it was not clear what NRC meant by the words "implementing it" in the statement "DOE has the responsibility for designing the LSS and bearing the costs associated with it and NRC will be responsible for implementing it."

NRC Response

In its Proposed Waste Confidence Decision Review, NRC included a description of the Licensing Support System (LSS) under its discussion of "Measures for dealing with Federal-State-Local concerns." The LSS is intended to provide participants in the repository licensing proceeding early access to documents relevant to the licensing decision.

To eliminate any confusion regarding NRC's responsibilities for the LSS, the above sentence in the [illegible]posed Decision Review wil[illegible]liminated and the following description will be inserted in its place: "DOE is responsible for the design, development, procurement and testing of the LSS. LSS design and development must be consistent with objectives and requirements of the Commission's LSS rulemaking and must be carried out in consultation with the LSS Administrator and with the advice of the Licensing Support System Advisory Review Panel. NRC (LSS Administrator) is responsible for the management and operation of the LSS after completion of the DOE design and development process."

Issue No. 7: Suggestion for Reducing Licensing Uncertainties Related to Spent Fuel Transshipments

Comment

Commonwealth Edison commented that in order to enhance the viability of the option of transferring spent fuel from retired reactors to others under active management, the NRC should reduce, to the maximum extent possible, licensing uncertainties related to such fuel transfers. The commenter also stated that by predetermining that spent fuel pool densification and alternative on-site spent fuel storage methods do not raise any significant hazards considerations, the NRC's final decision would be strengthened.

NRC Response

The Commission evaluates applications for modification of spent fuel storage at licensee's facilities or for transshipment from one site to another on an individual basis. Such a case-by-case consideration of the merits of each application ensures that all significant safety issues are addressed in a thorough manner and provides a conservative approach for arriving at a decision on the merits of the license application.

Issue No. 8: Appropriate Use of Nuclear Waste Fund Monies

Comment

Commonwealth Edison Company (CECo) refers to the NRC's statement that DOE could accept responsibility for management of spent fuel until a repository is available in the event that a licensee becomes insolvent prior to the time a geologic repository is ready to accept spent fuel. Funds from either the Nuclear Waste Fund (NWF) or from the utility itself could be used (54 FR 39767, at 39786 and 39790). CECo comments that the use of the NWF monies for this purpose would involve the solvent utilities funding the storage of spent fuel generated by the bankrupt licensees. CECo believes that it is not clear whether the Nuclear Waste would allow NWF monies t[illegible] this purpose and suggests th[illegible] should seek and analyze con[illegible] this issue. Until further evalu[illegible] analysis has taken place, CE[illegible] NRC should delete this as a b[illegible] confidence.

NRC Response

The Commission believes th[illegible] are two related issues presente[illegible] above comment. The first is wh[illegible] DOE can accept responsibility [illegible] fuel if a utility is insolvent or ot[illegible] no longer capable of managing i[illegible] second related issue is, given D[illegible] acceptance of responsibility for [illegible] spent fuel, where would DOE ob[illegible] funds needed to pay the costs of [illegible] responsibility? The NRC continue[illegible] believe that DOE would accept responsibility for spent fuel management in the event that a lic[illegible] is unable to exercise its own responsibility. Further, the NRC be[illegible] that DOE would have sufficient resources to carry out any safety-re[illegible] measures.

As indicated in the discussion unc[illegible] Issue 21, because DOE is not preclud[illegible] from accepting responsibility for the waste in those situations, default is a issue of equity rather than public hea[illegible] and safety. As such, the Commission does not believe that a licensee's potential default has a direct bearing c[illegible] the Commission's Waste Confidence Decision.

Nevertheless, because the source of funds, but not DOE's ultimate responsibility is ambiguous, the NRC has decided to change the references that CECo cites with the bracketed words to be deleted in the Final Waste Confidence Decision Review:

> If for any reason not now foreseen, this spent fuel can no longer be managed by the owners of these reactors, and DOE must assume responsibility for its management earlier than currently planned, this quantity of spent fuel is well within the capability of DOE to manage onsite or offsite with available technology [financed by the utility either directly or through the Nuclear Waste Fund]. (p.39786, col.1)
>
> Even if a licensed utility were to become insolvent, and responsibility for spent fuel management were transferred to DOE earlier than is currently planned, the Commission has no reason to believe that DOE would [have insufficient Nuclear Waste Fund resources or otherwise] be unable to carry out any safety-related measures NRC considers necessary. (p.39390, col.1)

Issue No. 9: Costs Incurred Due to Delayed Acceptance of Spent Fuel at Repository

Comment

Commonwealth Edison Company (CECo) observed that additional costs will be incurred by licensees as a result of delayed acceptance of spent fuel at the repository. CECo believes that consideration should be given as to whether these costs will be covered by the Nuclear Waste Fund or whether the costs will be incurred directly by the licensee.

NRC Response

The Commission believes that this is a matter which will have to be resolved in another forum in the context of the contracts between DOE and the utilities/owners of spent fuel. The individual contracts currently specify the dates by which DOE has agreed to accept responsibility for the disposal of spent fuel. If DOE must delay its acceptance of spent fuel, the responsibility for the financial consequences of that default would have to be determined at that time by reference to and interpretation of the pertinent contracts. The ultimate answer to this question will not affect the findings of the Waste Confidence Decision.

Issue No. 10: Clarification of Discussion of Period of Safe Spent Fuel Storage at Dresden 1

Comment

Commonwealth Edison Company (CECo) comments that the discussion in the Proposed Decision Review of the possible extended storage of spent fuel from Dresden 1 is not clear and should be clarified. On the basis of assumptions discussed in the Proposed Decision Review, CECo concludes that three different dates could be derived to indicate the maximum time for onsite spent fuel storage. For Dresden 1, which was licensed to operate in 1959 and permanently shut down in 1978, 30 years after shutdown would yield a maximum date of 2008; 30 years after a full 40-year license term yields a maximum date of 2029; and 30 years after a full 40-year license term plus a 30-year extension of the operating license would yield a date of 2059.

NRC Response

The NRC believes that CECo has misinterpreted the discussion pertaining to the maximum term of onsite spent fuel storage in the Waste Confidence Decision and the bases and assumptions underlying that discussion as they pertain to the specific circumstances of Dresden 1. The *generic* discussion of the derivation of the maximum safe storage term for the purposes of the Waste Confidence Decision is contained in pp.39785-90 and pp.39783-96. The Commission concluded on a generic basis that "spent fuel generated in *any* reactor can be stored safely and without significant environmental impacts in reactor facility storage pools or independent spent fuel storage installations located at-reactor or away-from-reactor sites for at least 30 years beyond the licensed life for operation (which may include the term of a revised license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installations" (proposed 10 CFR 51.23(a) at p. 39968 (Finding 4) (emphasis added)). The discussion and findings were based on technical and institutional considerations that, for the sake of completeness, considered situations like those at Dresden 1 that differ from those with most reactors that are expected to operate to full term plus a possible extended license term. For Dresden 1, based on proposed § 51.23(a), the applicable storage period would be 30 years beyond the licensed life of operation, or until 2029.

2.3 The Commission's Third Finding

The Commission finds reasonable assurance that high-level radioactive waste and spent fuel will be managed in a safe manner until sufficient repository capacity is available to assure the safe disposal of all high-level waste and spent fuel.

Issue No. 11: Resolution of Contractual Conflicts Between DOE and Licensees

Comment

Commonwealth Edison Company (CECo) comments that the NRC has unnecessarily interjected itself into issues involved in the contracts between the DOE and licensees by NRC's statement that it would have more confidence if the DOE and licensees could resolve any uncertainties by reaching an early and amicable resolution as to how and when the DOE will accept responsibility for spent fuel. CECo believes that the implication in this statement is that licensees should amend their contracts with DOE to allow DOE additional time to perform under the contracts or that licensees should refrain taking action against DOE if it defaults under the contracts. CECo notes that NRC has stated that its confidence in safe storage is unaffected by potential contractual disputes between DOE and the spent fuel owners (54 FR 39792), therefore CECo believes that it would be appropriate for NRC to strike the statement and express no opinion regarding possible future disputes between DOE and licensees.

NRC Response

The Commission did not intend the implication that CECo perceives regarding any particular preferred outcome or suggested resolution of future potential contract disputes between DOE and contract holders. The Commission has stated that its confidence in safe storage is unaffected by any potential contractual dispute between DOE and spent fuel generators and owners as to responsibility for spent fuel storage. The Commission's further statement that it would be helpful if any future potential contract disputes could be resolved amicably merely expressed a concern that the waste management system operates smoothly and efficiently. The statement did not imply any additional impact on or repercussion from the Waste Confidence Decision upon the resolution of future potential contract disputes between DOE and contract holders.

The Commission believes that it has made its position clear that its confidence is not diminished by any potential contractual disputes between DOE and spent fuel owners. However, in order to avoid any further misunderstanding in this regard, the Commission has decided to delete the following statements in its Proposed Waste Confidence Decision Review from its Final Waste Confidence Decision Review:

To resolve any continuing uncertainties, however, it would be helpful if DOE and utilities and other spent fuel generators and owners could reach an early and amicable resolution to the question of how and when DOE will accept responsibility for spent fuel. This would facilitate cooperative action to provide for a smoothly operating system for the ultimate disposition of spent fuel. (54 FR 39792) and

If DOE and the utilities can amicably resolve their respective responsibilities for spent fuel storage in the interest of efficient and effective administration of the overall waste management system, including the Nuclear Waste Fund, NRC would gain added confidence in the institutional arrangements for spent fuel management. (54 FR 39797)

Issue No. 12: NRC Responsibility to Identify Need for Utilities to Provide Interim Storage and to Notify Congress of This Requirement

Comment

Malachy Murphy (State of Nevada) comments that, in light of DOE's Reassessment Report to Congress, the NRC should explicitly state that utilities will need to have interim spent fuel storage available well into the next century. The commenter also states that NRC should explicity request that Congress take note of this requirement. The commenter believes that such action would be in keeping with NRC's responsibilities to the public and to nuclear utilities.

NRC Response

The standard contracts between DOE and generators of spent nuclear fuel or persons holding title to spent fuel currently provide that in return for payment to the Nuclear Waste Fund, DOE will dispose of high-level waste and spent fuel beginning no later than January 31, 1998. The Commission believes it would be inappropriate for NRC to take any position on the need for generators and those holding title to such material to provide interim storage for it beyond 1998. This is a matter that will have to be resolved between the parties to the standard contracts. NRC, in its original Waste Confidence Decision and in the Proposed Waste Confidence Decision Review, addressed the issue of storage of spent fuel until a repository becomes available and has expressed its confidence that spent fuel will be safely managed until a repository is available. Furthermore, in its original Waste Confidence Proceeding, NRC amended its reactor licensing rule, 10 CFR part 50 to require each licensed reactor operator to submit, no later than five years before expiration of the operating license, plans for managing spent fuel at the reactor site until the spent fuel is transferred to DOE for disposal.

In the Nuclear Waste Policy Act (NWPA), Congress placed primary responsibility for interim storage of spent fuel on the nuclear utilities until disposal becomes available. Section 132 of the NWPA requires that DOE, NRC, and other authorized Federal officials take such actions as they believe are necessary to encourage and expedite the effective use of available storage, and necessary additional storage, at the site of each civilian nuclear power reactor.

Sections 218(a) and 133 of the NWPA also provide that NRC by rule establish procedures for the licensing of any technology approved by NRC for use at the site of any civilian nuclear power reactor. NRC may by rule approve one or more dry spent fuel storage technologies for use at the sites of civilian power reactors without, to the maximum extent practicable, the need for additional site-specific approvals. Congress is eminently aware of the likely need for at-reactor storage of spent fuel and has taken legislative action with respect to this matter. Therefore, the NRC believes it is not necessary to inform Congress of this need. However, the NRC will continue to exercise its responsibility to assure that spent fuel is managed safely until a repository is available and will notify Congress of any actions it believes are necessary to provide this assurance.

2.4 The Commission's Fourth Finding

The Commission finds reasonable assurance that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin, or at either onsite or offsite independent spent fuel storage installations.

Issue No. 13: Consideration of the Cumulative Impacts on Waste Management in the NRC's NEPA Documentation

Comment

DOE commented that the cumulative impacts on waste management of potential reactor operating license extensions should be considered in the NRC's National Environmental Policy Act (NEPA) documentation for license renewals.

NRC Response

DOE has observed that renewal of operating licenses would increase the total amount of spent fuel requiring disposal or interim storage which would be taken into account in DOE program planning and should be considered in NRC's NEPA documentation for license renewals. This is generally consistent with the discussion in the Commission's proposed decision, especially 54 FR 39795 (third column). The greater amount of spent fuel which must be stored as a result of license renewal does not affect the Commission's overall finding of no significant environmental impacts.

Issue No. 14: Need for NRC to Facilitate ISFSI License Extensions to Reflect the Commission's Revised Fourth Finding

Comment

The Virginia Electric & Power Company (VEPCo) states that the current license on the Independent Spent Fuel Storage Installation (ISFSI) for its Surry nuclear power plant expires on July 31, 2006. VEPCo states that the NRC should initiate actions to facilitate ISFSI license extensions to reflect the proposed revised Fourth Finding that spent fuel generated in any reactor can be safely stored for at least 30 years beyond the licensed life for operation of that reactor either onsite or offsite.

NRC Response

The Commission's Waste Confidence finding on the duration of safe storage of spent fuel is generic in nature. Site-specific licensing procedures remain effective. Pursuant to § 72.42, an ISFSI license is issued for a period of 20 years but may be renewed upon application by the licensee. Part 72 in no way precludes licensees from requesting additional extensions of license terms for ISFSIs. The licensee thus has the option of requesting an ISFSI license renewal to coincide with whatever operating term and post-operation spent fuel storage period is in effect for a particular reactor. For example, a single renewal could extend the Surry ISFSI license expiration date to the year 2026. The NRC does not believe that further revisions to § 72.42 to facilitate these license extensions are warranted at this time.

Issue No. 15: Insufficient Assurance on Duration of Safe Storage and Risk of Fire at a Spent Fuel Pool

Comment

Public Citizen stated that there is not adequate assurance that spent fuel will be stored safely at reactor sites for up to 30 years beyond the expiration of reactor operating licenses. This is even more the case if license extensions of up to 30 years are included. Public Citizen further stated that "the (Waste Confidence) policy statement fails to recognize that spent fuel buildup at reactor sites poses a growing safety hazard. The pools are not well protected from the environment (in many cases they are outside the reactor's containment structure) and have leaked in the past. For example, in December 1986 at the Hatch nuclear power plant in Baxley, Georgia, 141,000 gallons of radioactive water leaked out of the plant's fuel pool. More than 80,000 gallons of the water drained into a swamp and from there into the Altamaha River near the plant." Public Citizen added that "More recently, on August 16, 1988, a seal on a fuel pool pump failed at the Turkey Point nuclear plant near Miami, FL, causing some 3,000 gallons of radioactive water to leak into a nearby storm sewer. The shoes and clothing of approximately 15 workers were contaminated."

Public Citizen also stated that the danger posed by an accident in which enough pool water escaped to uncover the irradiated fuel assemblies would be greater than the operational incidents described above. According to the commenter, if a leak or pump failure caused the water level in a spent fuel pool to drop to a level which exposed the fuel assemblies, the remaining water might be insufficient to provide adequate cooling. The pool water could then heat to the boiling point, producing steam and causing more water to boil away. The danger then is that heat could continue to build up even further until the cladding which encloses the irradiated fuel pellets catches fire. The commenter continued saying that the

NRC itself, in the time since the original Waste Confidence Decision, has studied the issue of storage in reracked spent fuel pools and concluded in a 1987 report that the consequence of such a cladding fire could be a "significant" radiation release. The NRC report found:

(1) the natural air flow permitted by high-density storage racks is so restricted that potential for self-sustaining cladding fire exists; and

(2) with high-density racks providing "severely restricted air flow" the oxidation (burning) would be "very vigorous" and "failure of both the fuel rods and the fuel rod racks is expected."

Public Citizen states that nowhere in the Proposed Waste Confidence Decision Review does the NRC take into account the findings of this report, which should have been included.

NRC Response

The Commission has addressed the safety of extended post-operational spent fuel storage at considerable length in the discussion of its proposed revised Fourth Finding.

Operational occurrences cited in Public Citizen's comment have been addressed by the NRC staff at the plants listed. The NRC has taken inspection and enforcement actions to reduce the potential for such operational occurrences in the future. We would like to note, however, that the event at the Hatch plant occurred in a transfer canal between spent fuel pools during an operation that would not normally be performed following expiration of a reactor operating license. In the case of the event at Turkey Point, the water that flowed outside the building went back into the intake of the plant cooling canal. The canal is a large, closed loop onsite flow path. There was no radiation release offsite, and the safety significance of the event appears to have been very low.

Regarding the risk of fire at spent fuel pools, the NRC staff has spent several years studying in detail catastrophic loss of reactor spent fuel pool water possibly resulting in a fuel fire in a dry pool. The 1987 report, "Severe Accidents in Spent Fuel Pools in Support of Generic Safety Issue 82" (NUREG/CR-4982), referred to in Public Citizen's comment represents an early part of the NRC's study. Its findings were based on generic data on seismic hazards and response of spent fuel pools, which resulted in calculated risk numbers with wide ranges of uncertainty. (See p. xiii.) Subsequent study of the consequences and risks due to a loss of coolant water from spent fuel pools was conducted by the NRC, and the results were published in NUREG/CR-5176, "Seismic Failure and Cask Drop Analysis of the Spent Fuel Pools at Two Representative Nuclear Power Plants," January 1989, and NUREG-1353, "Regulatory Analysis for the Resolution of Generic Issue 82, >Beyond Design Basis Accidents in Spent Fuel Pools'," April 1989. These reports were cited in the Commission's Proposed Waste Confidence Decision Review (54 FR 39767-39797, at p.39795, September 28, 1989). Also issued in 1989, as part of the NRC staff's study, was "Value/Impact Analyses of Accident Preventive and Mitigative Options for Spent Fuel Pools" (NUREG/CR-5281).

The analyses reported in these studies indicate that the dominant accident sequence which contributes to risk in a spent fuel pool is gross structural failure of the pool due to seismic events. Risks due to other accident scenarios (such as pneumatic seal failures, inadvertent drainage, loss of cooling or make-up water, and structural failures due to missiles, aircraft crashes and heavy load drops) are at least an order of magnitude smaller. For this study, older nuclear power plants were selected, since the older plants are more vulnerable to seismic-induced failures.

It should be noted that for a zircaloy cladding fire in a spent fuel storage pool, an earthquake or other event causing a major loss of cooling water would have to occur within two years after operation of a PWR or six months after operation of a BWR. (See NUREG-1353, p. 4-11.) Thus, during the decades of post-operational storage, even a major loss of cooling water would not be sufficient to cause a cladding fire. During the time the pool would be most vulnerable to a fire, the most-recently discharged fuel assemblies would have to be adjacent to other recently discharged assemblies for a fire to propagate to the older fuel. Considering that a third of the reactor core is typically unloaded as spent fuel each year, the probability of a fire involving even the equivalent of a reactor core--a small portion of a pool's capacity--is quite remote.

It should also be noted that even if the timing of a spent fuel pool failure were conducive to fire, a fire could occur only with a relatively sudden and substantial loss of coolant--a loss great enough to uncover all or most of the fuel, damaging enough to admit enough air from outside the pool to keep a large fire going, and sudden enough to deny the operators time to restore the pool to a safe condition. Such a severe loss of cooling water is likely to result only from an earthquake well beyond the conservatively estimated earthquake for which reactors are designed. Earthquakes of that magnitude are extremely rare.

The plant-specific studies following the 1987 generic study found that, because of the large safety margins inherent in the design and construction of their spent fuel pools, even the more vulnerable older reactors could safely withstand earthquakes several times more severe than their design basis earthquake. Factoring in the annual probability of such beyond-design-basis earthquakes, the plant-specific and generic followup studies calculated that the average annual probability of a major spent fuel pool failure at an operating reactor was ten to thirty times lower than the average probabilities in the 1987 study. (See NUREG/CR-5176, p. xiii, and NUREG-1353, pp. ES-2-3.) For either BWR or PWR designs, this probability was calculated at two chances in a million per year of reactor operation. (See NUREG-1353, pp. ES-3-4.)

After evaluating several regulatory options for reducing the risk of spent fuel pool fires, the NRC regulatory analysis concluded that "[t]he risk[s] due to beyond design basis accidents in spent fuel pools, while not negligible, are sufficiently low that the added costs involved with further risk reductions are not warranted." (See NUREG-1353, pp. ES-6-8.)

Issue No. 16: Need for NRC Requirement for Dry Cask Storage Instead of Storage in Spent Fuel Pools

Comment

Public Citizen states that the use of dry cask storage for spent fuel would help address some of the concerns described above, but that NRC has no plans to require dry cask storage instead of storage in spent fuel pools. The commenter notes that NRC has explicitly stated in its Proposed Decision Review that storage in a reactor's "spent fuel storage basin" is considered safe, and (the commenter) apparently disagrees with this conclusion.

NRC Response

The record of operational experience with reactor spent fuel storage pools, as discussed in the Commission's Proposed Decision Review and in response to the preceding comments, strongly supports the conclusion that reactor spent fuel pool storage, which has continued for decades, is safe. Accordingly, the NRC has reached the conclusion that past experience and available information amply support the safety of spent fuel storage, both in pools and dry storage casks, for at least 30 years past the expiration of reactor operating licenses (including the term of a revised license).

Issue No. 17: Suggestion to Revise Proposed Fourth Finding to Reflect Reasonable Assurance that Spent Fuel Can Be Safely Stored in Dry Casks at Reactor Sites for Up to One Hundred Years

Comment

Malachy Murphy (State of Nevada) commented that NRC's Proposed Revised Fourth Finding did not go far enough with respect to the duration of safe storage in dry storage casks. The commenter suggested that both the proposed finding and the Proposed Amendment to 10 CFR 51.23 be amended to reflect reasonable assurance that spent fuel can be stored safely and without significant environmental risk in dry casks at reactor sites for up to one hundred (100) years.

NRC Response

The Commission does not dispute a conclusion that dry spent fuel storage is safe and environmentally acceptable for a period of 100 years. Evidence supports safe storage for this period. A European study published in 1988 states, "In conclusion, present-day technology allows wet or dry storage over very long periods, and up to 100 years without undue danger to workers and population." (See Fettel, W., Kaspar, G., and Gunther, H., "Long-Term Storage of Spent Fuel from Light-Water Reactors" (EUR 11866 EN), Executive Summary, p.v, 1988.)

Although spent fuel can probably be safely stored without significant environmental impact for longer periods, the Commission does not find it necessary to make a specific conclusion regarding dry cask storage in this proceeding, as suggested by the commenter, in part because the Commission's Proposed Fourth Finding states that the period of safe storage is "at least" 30 years after expiration of a reactor's operating license. The Commission supports timely disposal of spent fuel and high-level waste in a geologic repository, and by this Decision does not intend to support storage of spent fuel for an indefinitely long period.

Issue No. 18: Maintenance of Institutional Controls for One Hundred Years

Comment

Marvin Lewis commented that the Commission's Proposed Revised Decision and Amendment to 10 CFR part 51 both require that at-reactor storage be available and safe for at least 100 years, which is an excessive amount of time to depend on institutional memory. The commenter states that to look into the future and have confidence that our institutions will survive in a form which will provide that safe onsite storage is available for at least 100 years into the future lacks any merit. The commenter asked that the Commission arrive at the opposite conclusion, namely that "Due to the Department of Energy's lack of quality control of data and analysis, inability to qualify acceptable sites, accusation against subcontractors when data contradicts DOE's preconceived assumptions, and general adherence to the political solution instead of scientific veracity, the NRC cannot find that temporary storage at reactors will ensure that geological storage for spent fuel will be available and safe when needed."

NRC Response

The Commission believes there is an adequate basis from the record of Federal regulations, historical experience and current practice to support the Commission's finding regarding institutional controls over spent fuel storage activities.

The Environmental Protection Agency's standards for high-level waste disposal provide that "active institutional controls over disposal sites should be maintained for as long a period of time as is practicable after disposal; however, performance assessments that assess isolation of the wastes from the accessible environment shall not consider any contributions from active institutional controls for more than 100 years after disposal" (40 CFR 191.14(a)). The finding that repository licensing performance assessments can take credit for active institutional controls for 100 years is not one of the issues involved in the judicial action which vacated the EPA standard, and it is not expected that this section will be disturbed when the standard is reissued. It should also be noted that this language does not suggest that active institutional controls are unlikely for a period greater than 100 years. In the summary of the Final Rule (50 FR 38066; September 19, 1985), EPA noted that many commenters on the Proposed Rule felt that "a few hundred years" which was the proposed period for reliance on active institutional controls was too long. EPA agreed to limit the period to 100 years, noting that "this was the time period [EPA] considered in criteria for radioactive waste disposal that were proposed for public comment in 1978 (43 FR 53262), a period that was generally supported by the commenters on that proposal" (50 FR 38066, at p. 38080).

NRC would add that there are abundant examples of institutions in human society which have maintained a continuity in institutional controls far exceeding 100 years. The governme the United States, which is relative young, is over 200 years old. The governments of some European countries have been in existence for time periods between 700 to 1000 ye. While invading armies and civil war have been disruptive, archival information of interest to the safety c the population can be expected to be preserved. In the United States today real estate contracts are commonly executed to cover a period of 100 year or a significant fraction thereof. One hundred-year land-lease agreements a common. Major civil construction projects such as harbors, bridges, flooc control systems, and dams are often planned and executed--and investment made in them--with the view of recovering the benefits over a period of 100 years or more.

2.5 The Commission's Fifth Finding

The Commission finds reasonable assurance that safe independent onsite or offsite spent fuel storage will be made available if such storage capacity is needed.

Issue No. 19: Impact of Extension of Time for Repository Availability on the Increased Generation of Low-Level Radioactive Waste

Comment

Commonwealth Edison (CECo) commented that the Proposed Waste Confidence Review does not address low-level waste concerns resulting from delayed acceptance of spent fuel by the repository under DOE's extended schedule for repository availability. CECo commented that if they store spent fuel in pools and implement rod consolidation to conserve space during the extension, additional low-level waste may be generated. CECo believes that NRC should determine if this additional low-level waste should go to a Federal Repository or to a sited compact for disposal.

NRC Response

The disposition of high-level and low-level radioactive wastes has already been determined by Congress in the Nuclear Waste Policy Act of 1982 (NWPA) and in the Low-Level Radioactive Waste Policy Act (LLWPA). Congressional designation of the method of disposal of each type of waste was not dependent on the DOE's schedule for development of the repository; rather, Congress designated the method of disposal according to characteristics of the waste which are associated with its hazard (i.e., radioactive source strength, radioactive species of the emanating radiation, and half-life). It is not within the NRC's regulatory

jurisdiction to change the directives provided by Congress in the NWPA and the LLWPA.

3.0 Consideration of Other Events Relevant to the Commission's Decision

Issue No. 20: Petition by the State of Vermont to Intervene in the Consideration of the Extension of the Operating License for Vermont Yankee

In the Commission's Proposed Waste Confidence Decision Review, it was stated that the basis for the 2007-2009 timeframe in the Court remand leading to the Waste Confidence Proceeding had changed since the original Decision. This discussion was based on the fact that it appeared likely that these dates no longer represented the expected expiration dates for the operating licenses of the Vermont Yankee and Prairie Island nuclear plants. The NRC staff has been granting extensions of the dates of expiration of nuclear plant operating licenses to reflect a 40-year period from the date of issuance of the operating license rather than from the date of the construction permit. The dates of expiration of the Prairie Island Units 1 and 2 had already been extended from the year 2006 to the years 2013 and 2014. The NRC staff anticipated that on the basis of the date of issuance of its operating license, Vermont Yankee would be eligible for an extension of its operating license to March 2012.

In the time since the drafting of the Proposed Decision Review, several pertinent events have occurred. NRC published a notice of consideration of amendment to the Vermont Yankee Operating License, a proposed "no significant hazards" consideration determination, and opportunity for a hearing (54 FR 31120; July 26, 1989). On August 22, 1989, the State of Vermont filed a petition for leave to intervene. On October 30, 1989, Vermont filed a supplement to its petition to intervene proposing nine contentions for litigation on Vermont Yankee Nuclear Power Corporation's application to extend its operating license. On November 15, 1989, the NRC's Atomic Safety and Licensing Board (ASLB) heard oral argument by counsel for the licensee, the NRC staff, and the State of Vermont concerning the State's petition for leave to intervene and supplemental petition for leave to intervene. The ASLB granted the State of Vermont's petition for leave to intervene, admitted one contention (which did not concern waste disposal) as an issue in controversy for litigation, and granted the request for hearing. The ASLB's ruling was issued in a Prehearing Conference Memorandum and Order dated January 26, 1990 (Docket No.50-271-OLA-4).

It is now apparent that the extension of Vermont Yankee's operating license expiration date will be dependent on the outcome of this contested hearing. There is the possibility that a shorter extension or that no extension will be granted. In view of the uncertain outcome, the Commission will delete all discussion of a possible revised date for the Vermont Yankee operating license expiration and the revised date for expiration of the Prairie Island operating license. This deletion, however, does not affect the Commission's Proposed Revised Second Finding in its Waste Confidence Decision Review. Assuming that no extension or a lesser extension is granted and Vermont Yankee's operating license expires in 2007, the basis for the Commission's finding that a repository will be available within the first quarter of the twenty-first century and that sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor, would be unaffected.

Issue No. 21: Potential Need for Additional Financial Security for the Nuclear Waste Fund

The NRC staff has been informed by DOE's Office of Civilian Radioactive Waste Management that a pending final report from DOE's Inspector General has indicated a potential problem for certain nuclear utility licensees to pay the one-time fee into the Nuclear Waste Fund (NWF) for spent fuel generated prior to April 1983. This issue arises because several utilities elected to defer payment into the fund and, instead, themselves hold the money that was collected from ratepayers for the one-time fee. DOE's Inspector General believes that some of those utilities may not be able to make their payments when due.

The NRC staff met with DOE's Office of Civilian Radioactive Waste Management (OCRWM) on December 13, 1989 to discuss this issue and determine the potential impact on both NRC's Decommissioning Rulemaking and on the Waste Confidence Decision, and, more generally, on protection of public health and safety. In addition, NRC discussed at that meeting and in follow-up telephone conversations potential actions that DOE might take. These actions could include modifying DOE's spent fuel contracts with electric utilities, seeking legislative amendments, and working with the National Association of Regulatory Utility Commissioners to increase assurance of one-time contributions into the NWF.

The NRC understands from OCRWM staff that, if a nuclear utility licensee were to default on its one-time contribution to the NWF, DOE is not precluded from accepting for disposal all spent fuel from that utility. Thus, the NRC does not view this issue as affecting its confidence that the spent fuel will be disposed of. Rather, the issue is one of equity--that is, will a utility and its customers and investors or U.S. taxpayers and/or other utilities ultimately pay for disposal of spent fuel generated prior to April 1983.

Background

In November 1976, the Natural Resources Defense Council (NRDC) petitioned NRC for a rulemaking to determine whether radioactive wastes generated in nuclear power reactors can be subsequently disposed of without undue risk to the public health and safety. The NRDC also requested that NRC not grant pending or future requests for operating licenses until the petitioned finding of safety was made.

On June 27, 1977, NRC denied the NRDC petition. The Commission said that in issuing operating licenses, NRC must have assurance that wastes can be safely handled and stored as they are generated. It also said that it is not necessary for permanent disposal to be available if NRC could be confident that permanent disposal could be accomplished when necessary. NRC added that Congress was aware of the relationship between nuclear reactor operations and the radioactive waste disposal problem, and that NRC would not refrain from issuing reactor operating licenses until the disposal problem was resolved. The Commission also stated that it "...would not continue to license reactors if it did not have reasonable confidence that the wastes can and will in due course be disposed of safely."

Also in November 1976, two utility companies requested amendments to their operating licenses to permit expansion in the capacity of their spent nuclear fuel storage pools: Vermont Yankee Nuclear Power Corporation for the Vermont Yankee plant; and Northern States Power Company for its Prairie Island facility. In both cases, the utilities planned to increase storage capacity through closer spacing of spent fuel assemblies in existing spent fuel pools. The New England Coalition on Nuclear Power and the Minnesota Pollution Control Agency intervened. The NRC staff evaluated the requests and found that the modifications would not endanger public health and safety. The staff did not consider any potential

environmental effects of storage of spent fuel at the reactors beyond the dates of expiration of their operating licenses. NRC's Atomic Safety and Licensing Board Panel (ASLBP) adopted the staff's safety and environmental findings and approved the license amendments for the two plants. It too did not consider the effects of at-reactor storage beyond the expiration of the facility operating license.

The Board's decision was appealed to the Atomic Safety and Licensing Appeal Board (ASLAB). The ASLAB affirmed the Licensing Board's decision, citing the Commission's "...reasonable confidence that wastes can and will in due course be disposed of safely...." in the Commission's denial of the NRDC petition. The decision of the ASLAB was appealed to the U.S. Circuit Court of Appeals. On May 23, 1979 the Court declined to stay or vacate the license amendments, but remanded to NRC the question of "...whether there is reasonable assurance that an offsite 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 safely stored at the reactor sites beyond those dates." In its decision to remand to NRC, for consideration in either a generic rulemaking or an adjudicatory proceeding, the Court observed that the issues of storage and disposal of nuclear waste were being considered by the Commission in an ongoing generic proceeding known as the "S-3 Proceeding" on the environmental impacts of uranium fuel cycle activities to support the operation of a light water reactor, and that it was appropriate to remand in light of a pending decision on that proceeding and analysis.

On October 16, 1979, NRC announced that it was initiating a rulemaking proceeding in response to the Appeals Court remand and as a continuation of the NRDC proceeding. Specifically, the purpose of the proceeding was for the Commission "...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 disposed of."

The Commission recognized that the scope of this proceeding would be broader than the Court's instruction, which required the Commission to address only storage-related questions. The Commission believed, however, that the primary public concern was the safety of waste disposal rather than the availability of an off-site solution to the storage problem. The Commission also committed itself to reassess its basis for confidence that methods of safe permanent disposal for high-level waste would be available when needed. Thus, the Commission chose as a matter of policy not to confine itself exclusively to the narrower issues in the court remand.

In the Notice of Proposed Rulemaking, the Commission also stated that if the proceeding led to a finding that safe off-site storage or disposal would be available before expiration of facility operating licenses, NRC would promulgate a rule providing that the impact of onsite storage of spent fuel after expiration of facility operating licenses need not be considered in individual licensing proceedings.

The Waste Confidence Decision was issued on August 31, 1984 (49 FR 34658). In the Decision, the Commission made five findings. It found reasonable assurance that:

(1) Safe disposal of high-level radioactive waste and spent fuel in a mined geologic repository is technically feasible.

(2) One or more mined geologic repositories for commercial high-level radioactive waste and spent fuel will be available by the years 2007-2009, and sufficient repository capacity will be available within 30 years beyond expiration of any reactor operating license to dispose of existing commercial high-level radioactive waste and spent fuel originating in such reactor and generated up to that time.

(3) High-level radioactive waste and spent fuel will be managed in a safe manner until sufficient repository capacity is available to assure the safe disposal of all high-level radioactive waste and spent fuel.

(4) If necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the expiration of that reactor's operating license at that reactor's spent fuel storage basin, or at either onsite or offsite independent spent fuel storage installations.

(5) Safe independent onsite or offsite spent fuel storage will be made available if such storage capacity is needed.

On the day the Decision was issued, the Commission also promulgated two rulemaking amendments: (1) an amendment to 10 CFR part 50, which required that no later than five years before expiration of reactor operating licenses, the licensee must provide NRC with a written plan for management of spent fuel onsite, until title for the spent fuel is transferred to the DOE; and (2) an amendment to 10 CFR part 51 which provided that environmental consequences of spent fuel storage after expiration of facility licenses need not be addressed in connection with issuance of or amendment to a reactor operating license.

In issuing the part 51 amendment, the Commission stated that although it had reasonable assurance that one or more repositories would be available by 2007-2009, it was possible that some spent fuel would have to be stored beyond those dates. The part 51 amendment was based on the Commission's finding in the Waste Confidence Proceeding that it had reasonable assurance that no significant environmental impacts will result from storage of spent fuel for at least 30 years beyond expiration of reactor operating licenses.

Enactment of the NWPA contributed significantly to the basis for the Commission's 1984 Decision and companion rulemakings. The Act established a funding source and process with milestones and schedules for, among other things, the development of a monitored retrievable storage (MRS) facility and two repositories, one by early 1998 and a second, if authorized by Congress, at a later date, initially planned by DOE for 2006. For each repository, the Act required DOE to conduct *in-situ* investigations of three sites and recommend one from among them to the President and Congress for repository development. The NWPA also required DOE to recommend, from among alternative sites and designs, a site and design for an MRS for spent fuel and high-level waste management before disposal. The Commission's licensing and regulatory authority over both storage and disposal facilities was preserved by the Act.

In the four years after enactment of the NWPA, DOE met a number of the Act's early program requirements, but also encountered significant difficulties. It published a final Mission Plan for the overall NWPA program, and followed with a Project Decision Schedule for DOE and other Federal agency actions. It promulgated, with Commission concurrence, a set of guidelines for repository siting and development. It published draft and final environmental assessments for nine candidate repository sites, and recommended three for characterization. It completed and submitted to Congress an environmental assessment, a program plan, and a proposal with a site and design for an MRS. All these actions followed extensive interactions with interested Federal agencies, State, Indian tribal, and local governments, and other

... slipped its ... operation of the first repository by five years, indefinitely postponed efforts ... ard a second repository, and ha... halt further MRS siting and development activities pending Congressional authorization.

In December, 1987, Congress enacted the Nuclear Waste Policy Amendments Act (NWPAA). The NWPAA redirected the high-level waste program by suspending site characterization activities for the first repository at sites other than the Yucca Mountain site, and by suspending all site-specific activities with respect to a second repository. The Amendments Act also authorized and set schedule and capacity limits on the MRS. The purpose of these limitations, according to sponsors of the legislation, was to assure that an MRS would not become a substitute for a geologic repository.

Consistent with its commitment to revisit its Waste Confidence conclusions at least every five years, the Commission has undertaken the current review to assess the effect of these and other developments since 1984 on the basis for each of its five findings. The Commission issued its proposed Waste Confidence Decision Review and proposed revised findings for public comment on September 28, 1989. The comment period expired December 27, 1989. A total of eleven comments were received.

In this document, the Commission supplements the basis for its earlier findings and the environmental analysis of the 1984 Decision. The Commission is amending its second finding, concerning the timing of initial availability and sufficient capacity of a repository, and its fourth finding, concerning the duration of safe spent fuel storage. These revisions are based on the following considerations:

(1) the five-year slippage, from 1998 to 2003, in the DOE schedule for repository availability prior to issuance of its November 1989 "Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program" and its new target date of 2010 for repository availability announced in that report;

(2) the additional slip of four and one-half years since the January 1987 Draft Mission Plan Amendment in the DOE schedule for the excavation of the exploratory shaft;

(3) the need to continue accounting for the possibility that the Yucca Mountain site might be found unsuitable and that DOE would have to initiate efforts to identify and characterize another site for the first repository;

... statutory suspension of site-specific activities for the second repository;

(5) DOE's estimate that site screening for a second repository should start about 25 years before the start of waste acceptance; and

(6) increased confidence in the safety of extended spent fuel storage, either at the reactor or at independent spent fuel storage installations.

The Commission is also issuing an amendment to 10 CFR 51.23(a) to conform with the revisions to Findings 2 and 4 elsewhere in this issue of the Federal Register.

Organization and Table of Contents

In conducting this review, the Commission has addressed, for each of its 1984 Findings, two categories of issues. The first category consists of the issues the Commission considered in making each Finding at the time of the initial Waste Confidence Decision. For these issues, the Commission is interested in whether its conclusions, or the Finding these conclusions support, should be changed to address new or foreseeable developments that have arisen since the first Waste Confidence Decision. The second category of issues consists of those the Commission believes should be added to the 1984 issues in light of subsequent developments. (To enable the reader to follow more easily, the lengthy discussions of Findings 1 and 2 have been organized to address each original and new issue under subheadings.)

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Reaffirmed Finding 1: The Commission finds reasonable assurance that safe disposal of high-level radioactive waste and spent fuel in a mined geologic repository is technically feasible.

I.A. Issues Considered in Commission's 1984 Decision on Finding 1

I.A.1. The identification of acceptable sites

Under the Nuclear Waste Policy Act of 1982 (NWPA), the Department of Energy (DOE) had responsibility for identifying candidate sites for a geologic repository and for repository development. The first requirement leading to recommendation of candidate sites was formal notification of States with one or more potentially acceptable sites for a repository within 90 days of enactment of the NWPA. In February 1983, the DOE identified nine potentially acceptable sites for the first repository. Four of the sites were in bedded-salt formations, three were in salt domes, one in volcanic tuff, and one in basalt.

The NWPA required that each site nomination be accompanied by an environmental assessment (EA). In December 1984, DOE published Draft EAs (DEAs) for each of the nine sites identified as potentially acceptable and proposed the following sites for nomination: the reference repository location at Hanford, WA; Yucca Mountain, NV; Deaf Smith County, TX; Davis Canyon, UT; and Richton Dome, MS. In May 1986, DOE released Final EAs (FEAs) for the five sites nominated. At that time, DOE recommended that the Yucca Mountain, Hanford, and Deaf Smith County sites undergo site characterization. The President approved the recommendation.

The NRC staff provided extensive comments on both the DEAs and the FEAs. NRC concerns on the FEAs related primarily to DOE's failure to recognize uncertainty inherent in the existing limited data bases for the recommended sites, and the tendency of DOE to present overly favorable or optimistic conclusions. The primary intent of the comments was to assist DOE in preparing high-quality Site Characterization Plans (SCPs) for each site, as required under the NWPA, before excavation of exploratory shafts. NRC concerns can only be addressed adequately through the site characterization process, because one of the purposes of this process is to develop the data to evaluate the significance of concerns relative to site suitability.

NRC did not identify any fundamental technical flaw or disqualifying factor which it believed would render any of the sites unsuitable for characterization. Further, NRC did not take a position on the ranking of the sites in order of preference, because this could be viewed as a prejudgment of licensing issues. NRC was not aware of any reason that would indicate that any of the candidate sites was unlicenseable. Nor has NRC made any such finding to date with respect to any site identified as potentially acceptable.

In March 1987, Congress began drafting legislation to amend the repository program. NRC provided comments on a number of these draft amendments. In December 1987, the NWPAA was enacted. In a major departure from the initial intent of the NWPA, the new law required that DOE suspend site characterization activities at sites other than the Yucca Mountain site. This decision was not based on a technical evaluation of the three recommended sites or a conclusion that the Hanford and Deaf Smith sites were not technically acceptable. According to sponsors of the legislation, the principal purpose of the requirement to suspend characterization at these sites was to reduce costs. In effect, the NWPAA directed DOE to characterize candidate sites sequentially, if necessary, rather than simultaneously. If DOE determines at any time that the Yucca Mountain site is unsuitable, DOE is to terminate all site characterization activities and report to Congress its recommendations for further actions.

The NRC staff has identified numerous issues regarding the Yucca Mountain site that may have a bearing on the licenseability of that site. These issues will have to be resolved during site characterization. An example of a site issue that may bear on the question of suitability is tectonic activity, the folding or faulting of the earth's crust. In the 1984 Waste Confidence Decision, NRC noted that "...the potential sites being investigated by DOE are in regions of relative tectonic stability." The authority for this statement came from the Position Statement of the US Geological Survey (USGS). NRC has raised concerns regarding tectonic activity at the Yucca Mountain site in the comments on the draft and final EAs, in the draft and final Point Papers on the Consultation Draft Site Characterization Plan, and in the Site Characterization Analysis for the Yucca Mountain site. If it appears during site characterization that the Yucca Mountain site will be unable to meet NRC requirements regarding isolation of waste, DOE will have to suspend characterization at that site and report to Congress.

DOE's program of site screening in different geologic media was consistent with section 112(a) of the NWPA, which required that DOE recommend sites in different geologic media to the extent practicable. This strategy was to ensure that if any one site were found unsuitable for reasons that would render other sites in the same geologic medium unacceptable, alternate sites in different host rock types would be available. NRC referred to this policy in its 1984 Waste Confidence Decision, when it said, in support of its argument on technical feasibility, that "...DOE's program is providing information on site characteristics at a sufficiently large number and variety of sites and geologic

media to support the expectation that one or more technically acceptable sites will be identified."

NRC recognizes that simultaneous site characterization is not necessary to identify a repository site that would meet NRC's technical criteria for isolating wastes. Sequential site characterization does not necessarily preclude or hinder identification of an acceptable site for a repository. NRC did express concern to Congress, on several occasions during deliberations over the proposed legislation, that sequential site characterization could delay considerably the schedule for opening a repository if the site undergoing characterization were found to be unlicenseable. NRC also indicated that this potential for delay would have to be considered by NRC in reevaluating the findings in its Waste Confidence Decision. The impact of this redirection of the high-level waste program on the Commission's Waste Confidence findings is not on the ability to identify technically acceptable sites, but on the timing of availability of technically acceptable sites. Because characterization of multiple sites appears to be more directly related to the timing of repository availability than to the feasibility of geologic disposal, consideration of the above statement in light of the NWPAA program redirection will be discussed under Finding 2.

Another question bearing on whether technically acceptable sites can be found is whether compliance with Environmental Protection Agency (EPA) environmental standards for disposal of spent fuel and high-level waste can be demonstrated. These standards, originally promulgated in final form in September 1985, were vacated in July, 1987, by the U.S. Court of Appeals, and remanded to EPA for further consideration (see *NRDC* v. *EPA*, 824 F. 2d 1258). As originally promulgated, the standards set limits on releases of radioactive materials from the site into the accessible environment over a 10,000-year period following disposal. They also required that there be less than one chance in ten that the release limits will be exceeded in 10,000 years, and less than one chance in 1,000 that releases will exceed ten times the limits over 10,000 years.

In past comments on draft and proposed EPA standards, and in related NRC rulemaking efforts, NRC has expressed concern that probabilistic analyses should not be exclusively relied on to demonstrate compliance with EPA release limits. NRC's comments said in part that "...[t]he numerical probabilities in [the standards] would require a degree of precision which is unlikely to be achievable in evaluating a real waste disposal system." The comments went on to explain that "...identification of the relevant processes and events affecting a particular site will require considerable judgment and will not be amenable to accurate quantification, by statistical analysis, of their probability of occurrence." NRC believed then, and continues to believe, that it must make qualitative judgments about the data and methodologies on which the numerical probabilities were based.

In response to NRC concerns, EPA incorporated language into its 1985 standards that appeared to allow flexibility to combine qualitative judgments with numerical probability estimates in a way that might have made implementation of the EPA standards practicable. The text of those standards recognized that "proof of the future performance of a disposal system is not to be had in the ordinary sense of the word" with the substantial uncertainties and very long performance period involved. The 1985 standards emphasized that a "reasonable expectation"--rather than absolute proof--is to be the test of compliance. "What is required," the text of the standards said, "is a reasonable expectation, on the basis of the record..., that compliance...will be achieved." In an additional attempt to provide flexibility for implementation of the standards, EPA also provided that numerical analyses of releases from a repository were to be incorporated into an overall probability distribution only "to the extent practicable." This phrase appeared to allow some discretion for NRC to incorporate qualitative considerations into its license decision-making, rather than having to rely solely on numerical projections of repository performance. On the strength of these and other EPA assurances, the Commission did not object when the final standards were published in 1985.

The Commission also notes that the EPA standards, as promulgated in 1985, contained a provision for development of alternative standards by EPA. The Federal Register text (50 FR 38074, September 19, 1985) describing this alternative standards provision stated:

> There are several areas of uncertainty the Agency [EPA] is aware of that might cause suggested modifications of the standards in the future. One of these concerns is implementation of the containment requirements for mined geologic repositories. This will require collection of a great deal of data during site characterization, resolution of the inevitable uncertainties in such information, and adaptation of this information into probabilistic risk assessments. Although the Agency is currently confident that this will be successfully accomplished, such projections over thousands of years to determine compliance with an environmental regulation are unprecedented. If--after substantial experience with these analyses is acquired--disposal systems that clearly provide good isolation cannot reasonably be shown to comply with the containment requirements, the Agency would consider whether modifications to [the standards] were appropriate.

This statement suggests to the Commission that EPA would be willing to consider modifications to the standard's containment requirements in the event that their probabilistic formulation is found to hamper or preclude an adequate evaluation of a proposed repository's capability to isolate radioactive waste.

Pursuant to the remand by the Federal court in 1987, EPA is currently revising its standards for disposal of spent fuel and high-level waste. The court's decision directed that the remand focus on the ground water and individual protection requirements of the standards. Although the EPA standards are still undergoing development at this time, the Commission does not currently see a sufficient basis to withdraw its confidence in the feasibility of evaluating compliance with such standards. NRC staff will closely monitor the development of the repromulgated standards.

In sum, considering both past and current programs for characterizing sites, the Commission concludes that technically acceptable sites for a repository can be found. The Commission is confident that, given adequate time and resources, such sites can be identified, evaluated, and accepted or rejected on their merits, even if no more than one site is undergoing site characterization. This judgment does not rest on the acceptability of the Yucca Mountain site or any one future candidate site.

I.A.2. The development of effective waste packages.

I.A.2.a. Considerations in developing waste packages.

The NWPA required NRC to promulgate technical requirements and criteria to be applied in licensing a repository for high-level radioactive waste. Under Section 121 of the Act, these technical criteria must provide for use of a system of multiple barriers in the design of the repository and such restrictions on the retrievability of waste as NRC deems appropriate. The system of multiple barriers includes both engineered and natural barriers.

The waste package is the first engineered barrier in the system of multiple barriers to radionuclide escape. The waste package is defined as the "waste form and any containers, shielding, packing and other absorbent materials immediately surrounding an individual waste container." Before sinking an exploratory shaft for site characterization, DOE is required to prepare an SCP including a description of the waste form or packaging proposed for use at the repository, and an explanation of the relationship between such waste form or packaging and the geologic medium of the site.

The multiple barrier approach to radioactive waste isolation in a geologic repository is implemented in NRC requirements by a number of performance objectives and by detailed siting and design criteria. The NRC performance objective for the waste package requires substantially complete containment for a period of not less than 300 years nor more than 1000 years after permanent closure of the repository. The technical design criteria for the waste package require that interaction of the waste package with the environment not compromise performance of the package, the underground facility, or the geologic setting. Therefore, the waste package design must take into account the complex site-specific interactions between host rock, waste package, and ground water that will affect waste package and overall repository performance.

Under the NWPAA, DOE was required to suspend site characterization activities at sites other than the Yucca Mountain, NV site. Consequently, DOE has narrowed the range of waste package designs to a design tailored for unsaturated tuff at the Yucca Mountain site. This aspect of the high-level waste program redirection may facilitate and expedite the waste package design process insofar as it enables DOE to concentrate its efforts on developing a single design for a single site instead of three designs for sites in bedded salt, basalt, and unsaturated tuff.

Currently, DOE is evaluating uncertainties in waste package design related to waste form, container type, and environment. The current conceptual design for the waste package is based on several assumptions. The waste form is presumed to be ten-year-old spent fuel or high-level waste in the form of borosilicate glass in stainless-steel canisters. (In addition to spent fuel and high-level waste, the waste form may include greater-than-Class C (GTCC) low-level waste. This waste is not routinely acceptable for near-surface disposal under NRC regulations for disposal of low-level wastes, but is acceptable for disposal in a repository licensed for disposal of spent fuel and high-level wastes. This waste might include such materials as sealed sources and activated metals from the decommissioning of reactors and production facilities.)

Six materials are being considered for fabrication of containers, including austenitic steel (316L), nickel-based alloys (Alloy 825), pure copper (CDA 102), copper-based alloys (aluminum-bronze, CDA-613, and 70-30 Cu-Ni, CDA-715), and a container with a metal outer shell and ceramic liner. The reference container for the spent fuel and high-level waste is a 1.0-cm thick cylinder to be made of American Iron and Steel Institute (AISI) 304L stainless steel. This will be DOE's benchmark material, against which other materials are to be compared. DOE currently intends for spent fuel containers to be filled with an inert gas, such as argon, before being welded closed. In addition to these six materials, DOE also plans to assess the merits of alternative waste package materials and designs.

The reference repository location is in the unsaturated tuff of the Topopah Spring Formation underlying Yucca Mountain. According to DOE, little free-flowing water is thought to be present there to contribute to corrosion of the waste containers, although the degree of saturation in this tuff is estimated to be 65 (plus or minus) 19 percent of the available void space in the rock. DOE has acknowledged, however, that the greatest uncertainties in assessing waste package performance at Yucca Mountain stem from difficulty in characterizing and modeling the coupled geochemical-hydrologic processes that represent the interactions between the host rock, waste package, and ground water. The final waste package design will depend on the results of site characterization and laboratory testing to reduce uncertainty in predicting these interactions in the reference repository horizon. The final design will also be shaped by research in understanding the degradation of candidate container materials, and the characteristics of the likely reference waste forms.

Regarding the state of technology for developing long-lived waste package containers, the Swedish Nuclear Fuel and Waste Management Company (SKB), the organization responsible for radioactive waste disposal in Sweden, has described a container for spent fuel rods that consists of a 0.1-m thick copper canister surrounded by a bentonite overpack. The design calls for pouring copper powder into the void spaces in the canisters, compacting the powder using hot-isostatic pressing with an inert gas, and sealing the canisters. SKB estimates that the copper canister waste package has a million-year lifetime. (See also I.B.3. below.)

As noted in NRC's Final Point Papers on the Consultation Draft Site Characterization Plan, the Commission does not expect absolute proof that 100 percent of the waste packages will have 100 percent containment for 300 to 1000 years. Since that time, the NRC staff has completed its review of the December 1988 Site Characterization Plan for Yucca Mountain. Although the Commission continues to have concerns about DOE's waste package program, nothing has occurred to diminish the Commission's confidence that as long as DOE establishes conservative objectives to guide a testing and design program, in tuff or in other geologic media if necessary, it is technically feasible to develop a waste package that meets the performance objective for substantially complete containment.

I.A.2.b. Effect of reprocessing on waste form and waste package.

The Draft 1988 Mission Plan Amendment estimates that about 77,800 metric tons of heavy metal (MTHM) of spent nuclear fuel will be available for disposal by the year 2020. (This estimate is based on a "no new orders" assumption for commercial nuclear reactors and a 40-year reactor lifetime.) Also, approximately 9400 MTHM of reprocessed defense waste and a small amount of commercial reprocessed waste from the West Valley Demonstration Project is estimated to be available for disposal by 2020. The decision to locate the defense high-level waste in the repository for wastes from commercial power reactors resulted from the requirement in Section 8 of the NWPA that the President evaluate the possibility of developing a defense-waste-only repository. In February 1985, DOE submitted a report to the President recommending a combined commercial and defense repository. In April 1985, the President agreed that no basis appeared to exist for a defense-only repository and directed DOE to dispose of defense waste in the commercial repository.

About 6750 MTHM of reprocessed high-level waste from defense facilities at Savannah River, SC, Hanford, WA, and Idaho Falls, ID will be available by 2020 for disposal in the repository, according to the Draft 1988 Mission Plan Amendment. This waste will likely be solidified into a borosilicate glass

matrix. About 640 MTHM of reprocessed high-level waste will come from the West Valley Demonstration Project, a facility for wastes from discontinued commercial reprocessing of spent fuel at that site. This reprocessed waste also will be solidified, probably in a borosilicate glass waste form.

Waste-form testing for the Yucca Mountain site is focusing on both spent fuel and reprocessed high-level waste. The performance of the waste form in providing the first barrier to radionuclide migration is being evaluated on the basis of the physical and chemical environment of the waste form after disposal, the performance of the waste container, and the emplacement configuration.

A major limitation on glass waste-form testing is that the actual waste glasses to be disposed of are not available, and their exact composition will not be established until after further testing. Reference waste-glass compositions are being used for studies on the effect of variation in glass composition on performance. (These glass compositions are designed by Savannah River Laboratory (SRL) for defense high-level waste, and by Pacific Northwest Laboratory (PNL) for the commercial high-level wastes to be vitrified under the West Valley Demonstration Project Act.) The reference compositions will be revised when better analyses of the composition of the wastes at SRL and West Valley are available. The test program will seek to establish upper bounds on leaching of important radionuclides, and the extent to which glass fracturing increases leach rate. Other factors influencing leach rate are temperature, pH of the leaching solution, formation of solid layers on the surface of the waste glass, irradiation, water volume, and chemistry.

It is possible that renewed reprocessing of spent fuel from nuclear power reactors may result in a greater proportion of reprocessed waste to spent fuel than is currently anticipated. Although such a departure from the current plan to dispose of mostly unreprocessed spent fuel in the repository does not appear likely at this time, the Commission believes it is important to recognize the possibility that this situation could change.

The possibility of disposal of reprocessed waste as an alternative waste form to spent fuel assemblies was recognized by the Commission in the 1984 Waste Confidence Decision. The Commission noted that the disposal of waste from reprocessing had been studied for a longer time than the disposal of spent fuel, and that the possibility of reprocessing does not alter the technical feasibility of developing a suitable waste package. The Commission went on to say that there is evidence that the disposal of reprocessed high-level waste may pose fewer technical challenges than the disposal of spent fuel. As long as DOE uses conservative assumptions and test conditions for evaluating the performance of different waste forms against NRC licensing requirements, the Commission has no basis to change its finding that there is reasonable assurance that reprocessing does not reduce confidence in the technical feasibility of designing and building a waste package that will meet NRC licensing requirements in a variety of geologic media.

I.A.3. The development of effective engineered barriers for isolating wastes from the biosphere

I.A.3.a. backfill materials.

At the time of the 1984 Waste Confidence Decision, DOE was developing conceptual designs for backfill in several geologic media. Most candidate sites at that time were in saturated rock, and the conceptual designs included backfilling or packing around waste containers to prevent or delay ground water flow which could enhance corrosion and radionuclide transport near the waste containers. The conceptual design for the engineered barrier system at the Yucca Mountain site has different parameters because the site is unsaturated; instead of backfill or packing around the waste container, there is to be an air gap between sides of the waste canister and the host rock.

Backfill material around the container is not required under NRC regulations for the waste package. NRC regulations require that "...containment of high-level waste within the waste packages [which includes the container] will be substantially complete for a period to be determined by the Commission...provided, that such period shall not be less than 300 years nor more than 1000 years after permanent closure of the repository" [10 CFR subsection 60.113(a)(1)(ii)(B)], and that the entire engineered barrier system meet the release rate performance objective of 1 part in 100,000 per year.

Backfill is also a component of the borehole, shaft, and ramp seals, which are not part of the engineered barrier system or the underground facility. Boreholes, shafts, and ramps must be sealed when the repository is permanently closed. This aspect of backfilling is discussed below under "Development of Sealants." Backfill may also include crushed rock used to fill openings such as drifts in the underground facility. At the Yucca Mountain candidate site, DOE currently plans to fill openings in the underground facility at closure of the repository. Backfilling is not planned before repository closure because it is not needed for structural support for the openings, and it would make waste retrieval more difficult. At closure of the facility, however, openings will be backfilled with coarse tuff excavated for the facility. In the conceptual design provided in the SCP, the selection of coarse tuff as backfill material is based on numerical simulations performed by DOE which suggest that coarse tuff would be a more effective barrier to capillary flow in the backfill matrix than fine materials.

DOE's design for the engineered barrier system submitted with the license application will have to contain information sufficient for NRC to reach a favorable conclusion regarding the overall system performance objective. Backfill or packing around waste containers is not required by NRC regulations if DOE can demonstrate that applicable performance objectives can be met without it. If, on the basis of testing and experiments during site characterization, DOE decided that backfill would enhance engineered barrier system performance, the design would have to reflect this conclusion. DOE has already conducted research on a wide variety of candidate materials for backfill around waste packages in a variety of geologic media. The Commission continues to have confidence that backfill or packing materials can be developed as needed for the underground facility and waste package to meet applicable NRC licensing criteria and performance objectives.

I.A.3.b. Borehole and shaft seals.

The engineered barrier system described above is limited to the waste package and the underground facility as defined in 10 CFR part 60. The underground facility refers to the underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals. Containment and release-rate requirements are specified for the engineered barrier system, but not for the borehole and shaft seals. Seals are covered under 10 CFR section 60.112, the overall post-closure system performance objective for the repository. Among other things, this provision requires that shafts, boreholes and their seals be designed to assure that releases of radioactive materials to the accessible

environment following permanent closure conform to EPA's generally applicable standards for radioactivity. Although the criteria for seals given in 10 CFR part 60 do not specifically mention seals in ramps and the underground facility, it is reasonable to consider them together with borehole and shaft sealants, because the seals and drainage design in ramps and the underground facility could also affect the overall system performance of the geologic repository.

Construction of the exploratory shaft facility (ESF) will be the first major site characterization activity at the repository horizon. Currently, DOE is reviewing its plans for construction of exploratory shafts. According to the 1989 "Reassessment Report," DOE is reevaluating the "locations chosen for the two exploratory shafts, the method chosen (drilling and blasting) for the construction of the shafts, the means of access (ramps or shafts) to the repository horizon, the need for additional exploratory drifts, and the design of the shafts and other components of the exploratory shaft facility." This reevaluation of plans for the shaft facility is in response to concerns from the NRC staff and the Nuclear Waste Technical Review Board (NWTRB).

When the repository is decommissioned, NRC expects that most, if not all, shafts, ramps, and boreholes will probably have to be sealed to reduce the possibility that they could provide preferential pathways for radionuclide migration from the underground facility to the accessible environment. DOE estimates that as many as 350 shallow and 70 deep exploratory boreholes may be emplaced by the time site characterization has been completed at the Yucca Mountain site. Decommissioning may not occur for up to 100 years after commencement of repository operations. Because the final design for seals will likely have been modified from the initial license application design (LAD), DOE is viewing the seal LAD as serving two primary functions. As set forth in DOE's SCP for the Yucca Mountain candidate site, the seal LAD is to establish that: (1) "...technology for constructing seals is reasonably available;" and (2) "...there is reasonable assurance that seals have been designed so that, following permanent closure, they do not become pathways that compromise the geologic repository's ability to meet the post-closure performance objectives."

To establish the availability of technology for seal construction, DOE has identified at least 31 site properties that need to be characterized in determining necessary seal characteristics. These properties include saturated hydraulic conductivity of alluvium near shafts, the quantity of water reaching the seals due to surface-flooding events, and erosion potential in the shaft vicinity. The SCP also discusses material properties that need to be identified to determine sealing components such as initial and altered hydrologic properties of materials.

The SCP indicates that DOE is planning to use crushed tuff and cements in the sealing program at the Yucca Mountain candidate site. The stated advantages of using tuff include minimizing degradation of seal material and avoiding disruption of ambient ground-water chemistry.

DOE's current design concept for meeting the overall performance objectives includes a combination of sealing and drainage. Seal requirements may be reduced in part by: (1) limiting the amount of surface water that may enter boreholes, shafts, and ramps; (2) selecting borehole, shaft, and ramp locations and orientations that provide long flow paths from the emplaced waste to the accessible environment above the repository; and (3) maintaining a sufficient rate of drainage below the repository horizon level so that water can be shunted past the waste packages without contacting them.

Although DOE's program is focusing on seals for the Yucca Mountain candidate site, the Commission finds no basis for diminished confidence that an acceptable seal can be developed for candidate sites in different geologic media. The Commission finds no evidence to suggest that it can not continue to have reasonable assurance that borehole, shaft, ramp, and repository seals can be developed to meet 10 CFR part 60 performance objectives.

I.B. Relevant Issues That Have Arisen Since the Commission's Original Decision

I.B.1. In support of its argument on technical feasibility, the Commission stated in its 1984 Waste Confidence Decision that "...DOE's program is providing information on site characteristics at a sufficiently large number and variety of sites and geologic media to support the expectation that one or more technically acceptable sites will be identified." The NWPAA required, however, that DOE suspend site-specific site characterization activities under the Nuclear Waste Policy Act of 1982 at all sites other than the Yucca Mountain, NV site.

Under the NWPAA, the DOE program has been redirected to characterize candidate repository sites in sequence rather than simultaneously. If the Yucca Mountain site is found to be unsuitable, DOE must terminate site characterization activities there and provide Congress with a recommendation for further action, such as the characterization of another site. Because characterization of multiple sites now appears to be more directly related to the timing of repository availability than to the technical feasibility of geologic disposal as a concept, consideration of the Commission's aforementioned 1984 statement in light of the NWPAA will be discussed under Finding 2.

I.B.2. What is the relationship, if any, of the "S-3 Proceeding" to the current review of the Commission's 1984 Waste Confidence Findings? Would the planned revision of the S-3 rulemaking be affected if the Commission had to qualify its current confidence in the technical feasibility of safe disposal?

In its decision to remand to NRC the questions of whether safe offsite storage would be available by 2007-2009, or, if not, whether spent fuel could be safely stored onsite past those dates, the U.S. Circuit Court of Appeals observed that the issues of storage and disposal of nuclear waste were being considered by the Commission in an ongoing generic proceeding known as the "S-3" Proceeding.

The S-3 Proceeding was the outgrowth of efforts to address generically the NEPA requirement for an evaluation of the environmental impact of operation of a light water reactor (LWR). Table S-3 assigned numerical values for environmental costs resulting from uranium fuel cycle activities to support one year of LWR operation. NRC promulgated the S-3 rule in April 1974. In July 1976, the U.S. Circuit Court of Appeals found that Table S-3 was inadequately supported by the record regarding reprocessing of spent fuel and radioactive waste management, in part because the Commission, in reaching its assessment, had relied heavily on

testimony of NRC staff that the problem of waste disposal would be resolved.

When the U.S. Circuit Court of Appeals issued the remand on what were to become the "Waste Confidence" issues in May 1979, NRC had pending before it the final amended S-3 rule. The Court regarded the resolution of the issue of waste disposal in the S-3 proceeding as being related to the issue raised by the petitioners in the appeals of the NRC decisions on the expansion of spent fuel storage capacity. The Court said that the "...disposition of the S-3 proceeding, though it has a somewhat different focus, may have a bearing on the pending cases."

The Commission approved the final S-3 rule in July 1979. In October 1979, the Commission issued a Notice of Proposed Rulemaking (NPR) on the Waste Confidence issues in response to the remand by the Court of Appeals. In the NPR, the Commission stated that the proceeding would "...draw upon the record compiled in the Commission's recently concluded rulemaking on the environmental impacts of the nuclear fuel cycle, and that the record compiled herein will be available for use in the general fuel cycle rule update discussed in that rulemaking."

In the final Table S-3 rule issued in 1979, the Commission had said that "...bedded salt sites can be found which will provide effective isolation of radioactive waste from the biosphere." When the Commission issued the 1984 Waste Confidence Decision, part of the basis for the discussion of waste management and disposal in the August 1979 final S-3 rule had changed. For example, in 1984 the repository program was proceeding under the NWPA, which required that DOE recommend three sites for site characterization.

NRC is preparing to amend 10 CFR 51.51, adding new estimates for releases of Tc-99 and Rn-222, and a revised narrative explanation describing the basis for values contained in Table S-3. The amendment would also explain the environmental effects of potential releases from the light water reactor (LWR) fuel cycle, and postulate the potential radiation doses, health effects, and environmental impacts of these releases. It is unlikely that the revision will have any impact on the Commission's generic findings in the Waste Confidence proceeding. Nor is it likely that this reexamination of the Waste Confidence findings will affect the S-3 rule; the Waste Confidence Proceeding is not intended to make quantitative judgments about the environmental costs of waste disposal. Unless the Commission, in a future review of the Waste Confidence decision, finds that it no longer has confidence in the technical feasibility of disposal in a mined geologic repository, the Commission will not consider it necessary to review the S-3 rule when it reexamines its Waste Confidence findings in the future.

I.B.3. To what extent do developments in spent fuel disposal technology outside of the United States (e.g., Swedish waste package designs) enhance NRC's confidence in the technical feasibility of disposal of high-level waste and spent fuel?

Spent fuel disposal technology is the subject of extensive research investigation in both Europe and North America. Advances in this technology are being communicated to the NRC staff both through bilateral agreements and the presentation of research results at international meetings.

Outside the U.S., studies of spent fuel as a waste form are now being conducted primarily in Canada and Sweden, although both France and West Germany have small programs in this area. The Swedish studies have been mainly concerned with boiling water reactor (BWR) spent fuel, whereas the Canadian studies focus on spent fuel from that country's CANDU reactors, which use unenriched uranium in a core immersed in "heavy" water made from deuterium. BWR and CANDU fuel, like pressurized water reactor (PWR) fuel, are uranium dioxide fuels clad in zircaloy. However, the burnup rates for these three fuel types vary considerably. Ongoing research studies on spent fuel include: work on the characterization of spent fuel as a waste form; the corrosion of spent fuel and its dissolution under oxidizing and reducing conditions; the radiolysis of ground water in the near vicinity of the spent fuel, and its effects on the dissolution of the fuel; and the development of models to predict the leaching of spent fuel over long time periods. The results of this work are steadily increasing our understanding of spent fuel as a waste form.

High-level radioactive waste, whether it is spent reactor fuel or waste from reprocessing, must be enclosed in an outer canister as part of the waste package. The canister surrounding the waste is expected to prevent the release of radioactivity during its handling at the repository site before emplacement. After emplacement in the repository, it is expected to prevent the release of radioactivity for a specified period of time after the repository is closed, by providing a barrier to protect the waste from coming into contact with ground water.

For practical reasons, canister materials may be divided into the following classes: (1) completely or partially thermodynamically stable materials such as copper; (2) passive materials such as stainless steel, titanium, Hastelloy, Inconel, and aluminum; (3) corroding or sacrificial materials such as lead and steel; and (4) non-metallic materials such as alumina and titanium dioxide ceramics and cement.

Sweden has been conducting an extensive canister research program over the past several years. The main canister material of interest is copper, but titanium, carbon steel, and alumina and titanium dioxide are also being studied as reasonable alternatives, should unexpected problems be discovered with using pure copper.

One of the Swedish canister designs is a 0.1-m thick copper container (as described previously in section I.A.2.a.), which is claimed to provide containment, in conjunction with an appropriate backfill material, for a period on the order of one million years. The critical factors for the isolation period for copper canisters are: (1) the presence of corrosive substances such as sulphide ions in the ground water; (2) the possibility of these substances reaching the canister surface; and (3) the degree of inhomogeneity, or pitting, of the resulting corrosion. Studies are continuing to obtain more information on pitting corrosion of copper and on techniques for welding thick-walled copper containers.

Several conceptual designs for canisters for the safe disposal of unreprocessed spent fuel have also been developed in Canada. One canister design option is the supported-shell, metal-matrix concept, which involves packing the spent fuel bundles into a thin corrosion-resistant shell and casting the remaining space with a low melting point metal or alloy. Structural support for the shell would be provided by the resulting metal matrix. Lead is a possible matrix material because of its favorable casting properties, cost, and low melting point.

Other supported shell canister concepts include the packed-particulate and structurally-supported designs. In these designs, a thin outer shell is supported by a particulate material packed around a steel internal structure that contains the spent fuel bundles. Several materials have been identified for the fabrication of the corrosion resistant outer shell, including commercially pure and low-alloy titanium, high nickel-based alloys such as Inconel 625, and pure copper.

Detailed designs have been produced for all three types of supported shell canisters incorporating either a titanium or nickel alloy shell less than 6-mm thick. A conceptual design has also been produced for a copper-shell structurally-supported canister and a metal-matrix container with a relatively thick (25-mm) copper shell and a lead matrix material. This last canister is intended to contain 72 used CANDU fuel bundles in four layers of 18 bundles each.

Both the Canadian and Swedish conceptual designs for the disposal of spent fuel in canisters provide for surrounding the canister with backfill material as part of the waste package when it is emplaced in the repository. This backfill material would be packed around the canister to retard the movement of ground water and radionuclides. Investigations of backfill material at the Stripa mine in Sweden have shown that bentonite and silica sand can be employed successfully as backfill, both around the canister and in repository tunnels. A bentonite-silica mixture is the recommended backfill material on the basis of its thermal and mechanical properties. Bentonite backfills have been shown to produce hydraulic conductivities that are very similar to the surrounding granite at Stripa. Problems concerning the variability of bentonite samples from different geographic locations can be eliminated if material from a single source is used. The presence of sulfur and some organic material, including bacteria, in many bentonites poses some problems related to microbially-accelerated corrosion. Treatment with hydrogen peroxide may be used to oxidize these organics. Heating the bentonite to 400 degrees C can also be effective, although this may alter the crystal structure of the bentonite.

Many countries intend to dispose of their high-level radioactive waste by first converting the wastes into a solid, vitrified form after reprocessing. Since the leaching of the waste form by circulating ground water after disposal is the most likely mechanism by which the radionuclides might be returned to the biosphere, the waste form must be composed of a highly stable material with an extremely low solubility in ground water. Thus, the waste form itself should function as an immobilization agent to prevent any significant release of radionuclides to the biosphere over very long time periods. The two primary materials currently being considered for use as solidified waste forms are borosilicate glass and SYNROC, a man-made titanate ceramic material.

SYNROC was initially developed in Australia as an alternative material to borosilicate glass. It is composed primarily of three minerals (hollandite, zirconolite, and perovskite) which collectively have the capacity to accept the great majority of radioactive high-level waste constituents into their crystal lattice structure. These three minerals, or closely related forms, occur naturally, and have been shown to have survived for many millions of years in a wide range of natural environments. SYNROC has the property of being extremely resistant to leaching by ground water, particularly at temperatures above 100 degrees C. In addition, the capacity of SYNROC to immobilize high-level wastes is not markedly impaired by high levels of radiation damage.

The high leach-resistance of SYNROC at elevated temperatures increases the range of geologic environments in which it may be used, such as deep geologic repositories in both continental and marine environments.

Research and development work on improving SYNROC production technology is currently being done jointly in Australia and Japan. New methods of using metal alkoxides in the fabrication of SYNROC to obtain high homogeneity and lowered leachability have recently been developed in Australia. The Japanese have recently developed a new method that uses titanium hydroxide, as a reducing agent to produce SYNROC with a high density and low leach rate. A pilot facility for the production of non-radioactive SYNROC is now in operation in Australia, and a small pilot facility for producing SYNROC with radioactive constituents is being completed in Japan.

On the basis of current information from the foreign studies just described on canisters, spent fuel as a waste form, backfill materials, and alternatives to borosilicate glass waste forms, the Commission concludes that there is no basis for diminished confidence that an acceptable waste package can be developed for safe disposal of high-level waste and spent fuel.

I.C. Conclusion on Finding 1

The Commission has reexamined the basis for its First Finding in the 1984 Waste Confidence Decision in light of subsequent program developments, and concludes that Finding 1 should be reaffirmed.

The technical feasibility of a repository rests initially on identification of acceptable sites. At this time, the Commission is not aware of any evidence indicating that Yucca Mountain is not acceptable for site characterization. There are many outstanding questions regarding the licenseability of the site, however, and they must be answered satisfactorily in order for NRC to issue a construction authorization for that site. If data obtained during site characterization indicate that the Yucca Mountain site is not suitable for a repository, DOE is required by the NWPAA to terminate site characterization activities and report to Congress. Within six months of that determination, DOE must make a recommendation to Congress for further action to assure the safe, permanent disposal of spent fuel and high-level waste. DOE could recommend, for example, that Congress authorize site characterization at other sites. Considering DOE's investigations of other potentially acceptable sites before its exclusive focus on Yucca Mountain, the Commission has no reason to believe that, given adequate time and program resources, a technically acceptable site can not be found.

The technical feasibility of geologic disposal also depends on the ability to develop effective engineered barriers, such as waste packages. DOE is currently evaluating six candidate materials for waste containers, including austenitic steel and copper- and nickel-based alloys, and is planning waste-form testing based on both spent fuel and high-level waste in borosilicate glass. On the basis of DOE's program, and results from Swedish investigations of a copper waste container, the Commission is confident that, given a range of waste forms and conservative test conditions, the technology is available to design acceptable waste packages.

In addition to the materials testing for the waste container and waste form, there may be additional measures that can be taken to improve the effectiveness of the engineered barriers. It is known, for example, that the heat-loading characteristics of the wastes diminish with time. Also, the longer wastes are stored before disposal, the smaller will be the quantities of radionuclides available for transport to the accessible environment.

It is also technically feasible to separate from radioactive wastes the radionuclides that constitute the principal source of heat from the nuclides of greatest long-term concern. The former radionuclides, mainly fission products such as cesium-137 and strontium-90, could then be stored for a period of years while the fission products decay to the point where they could be disposed of either in a manner

that does not require the degree of confinement provided by a geologic repository, or in a repository with less concern for thermal disturbance of the host rock's expected waste isolation properties. Meantime, the longer-lived remaining radionuclides, such as transuranic wastes with elements heavier than uranium, could be disposed of in a repository away from the fission products and without the high thermal loadings that would otherwise have to be considered in predicting the long-term waste isolation performance of the geologic setting. France, Great Britain, and Japan are currently pursuing this waste management strategy or a variant of it.

The Commission emphasizes here that it does not believe that recycling technologies are required for the safety or feasibility of deep geologic disposal in the United States. Other countries, such as Canada, the Federal Republic of Germany, and Sweden are pursuing disposal strategies based on a similar view. Reprocessing, if employed in its current stage of development, would result in additional exposures to radiation and volumes of radioactive wastes to be disposed of. For the purpose of finding reasonable assurance in the technical feasibility of geologic disposal, however, it is worth noting that technology is currently available to permit additional engineering control of waste forms if, for reasons not now foreseen, such control were deemed desirable at some future time. Meanwhile, the Commission continues to have confidence that safe geologic disposal is technically feasible for both spent fuel and high-level waste.

DOE's reference design for the waste package in the December 1988 Site Characterization Plan does not include backfill or packing around waste containers in the emplacement boreholes. Neither is required under NRC rules so long as DOE can show that applicable regulatory criteria and objectives will be met. An air gap between the container and the host rock is currently one of the barriers in DOE's design for meeting the performance objective. DOE has conducted investigations on a variety of candidate materials for backfill in a variety of geologic media, and the Commission finds no basis to qualify its past confidence that backfill materials can be developed, if needed, to meet applicable NRC requirements.

The December 1988 reference design for sealing boreholes, shafts, ramps and the underground facility at the Yucca Mountain candidate site employs crushed tuff and cement. Regardless of the geologic medium of the candidate site, DOE will have to show that the license application design meets NRC post-closure performance objectives. The Commission continues to have reasonable assurance that DOE's program will lead to identification of acceptable sealant materials for meeting these objectives.

No major breakthrough in technology is required to develop a mined geologic repository. NRC will not be able to license a repository at a particular site, however, until there is sufficient information available for that site. The information needed to license a site includes site characterization data, data on repository design, and waste package design sufficient for performance assessment of the entire waste disposal system. Further, the Commission recognizes the challenge posed by the need to predict impacts of a repository on human health and the environment over very long periods of time. It will not be possible to test the accuracy of long-term repository performance assessment models in an absolute sense. The NRC does believe that existing performance assessment models have the potential to provide a basis for deciding whether a system for geologic disposal of high-level waste is acceptable, and can provide a sufficient level of safety for present and future generations under certain conditions. These conditions include addressing uncertainties, and gathering data from specific sites.

Overall, from its reexamination of issues related to the technical feasibility of geologic disposal, the Commission concludes that there is reasonable assurance that safe disposal of high-level waste and spent fuel in a mined geologic repository is technically feasible.

Original Finding 2: The Commission finds reasonable assurance that one or more mined geologic repositories for commercial high-level waste and spent fuel will be available by the years 2007-2009, and that sufficient repository capacity will be available within 30 years beyond expiration of any reactor operating license to dispose of existing commercial high-level radioactive waste and spent fuel originating in that reactor and generated up to that time.

Revised Finding 2: The Commission finds reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and that sufficient repository capacity will be available within 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of any reactor to dispose of the commercial high-level radioactive waste and spent fuel originating in such reactor and generated up to that time.

II.A. Issues Considered in Commission's 1984 Decision on Finding 2

II.A.1. Finding Technically Acceptable Sites in a Timely Fashion

In order for the Commission to find that any candidate site for a repository is technically acceptable (that is, in compliance with NRC licensing requirements), the site must undergo comprehensive site characterization to assess its hydrologic, geologic, geochemical, and rock mechanics properties. It is possible that a site may be found unacceptable on the basis of surface-based testing, early in-situ testing or other site characterization activities. It will not be possible, however, for the NRC staff to take a position before a licensing board that a site will meet NRC requirements for construction authorization until the results of all site characterization activities are available. Even then, the staff may conclude that the evidence from site characterization does not constitute reasonable assurance that NRC performance objectives will be met. Also, the results of the licensing hearings on construction authorization cannot be predicted. If construction is authorized and when it is substantially complete, DOE is required to obtain, in addition to the construction authorization permit, a license to receive and possess waste at the geologic repository operations area in order to commence repository operations. These considerations argue for maintaining the ready availability of alternative sites if, after several years, site characterization or licensing activities bring to light difficulties at the leading candidate site.

In support of its argument on technical feasibility, the Commission stated in its 1984 Waste Confidence Decision that "...DOE's program is providing information on site characteristics at a sufficiently large number and variety of sites and geologic media to support the expectation that one or more technically acceptable sites will be identified." At the time, DOE was required under the NWPA to characterize three candidate repository sites.

The NWPAA had a major impact on DOE's repository program, however. Under the NWPAA, DOE was required to suspend site-specific activities at the Hanford, WA and Deaf Smith County, TX sites, which had been approved by the President for site characterization for the first repository. Redirection of the repository program to single-site

characterization (or, if necessary, sequential site characterization if the Yucca Mountain site is found to be unsuitable) will permit DOE to concentrate its efforts and resources on information gathering at a single site, as opposed to spreading out its efforts over a range of sites. The possible schedular benefits to single-site characterization, however, must be weighed for the purposes of this Finding against the potential for additional delays in repository availability if the Yucca Mountain site is found to be unsuitable. By focusing DOE site characterization activities on Yucca Mountain, the NWPAA has essentially made it necessary for that site to be found suitable if the 2007-2009 timeframe for repository availability in the Commission's 1984 Decision is to be met. Clearly, the Commission cannot be certain at this time that the Yucca Mountain site will be acceptable.

Although the Commission has no reason to believe that another technically acceptable site can not be found if the Yucca Mountain site proves unsuitable, several factors raise reasonable doubts as to the availability of even one repository by 2007-2009. These include: (1) the current reliance on a single site with no concurrently available alternatives; (2) the probability that site characterization activities will not proceed entirely without problems; and (3) the history of schedular slippages since passage of the NWPA. For example, DOE's schedule for the first repository slipped five years (from 1998 to 2003) between January 1983, when the NWPA was enacted, and January 1987, when the first Draft Mission Plan Amendment was issued. The schedule for excavation of the exploratory shaft for the Yucca Mountain site has slipped by more than five years since the issuance of the PDS in March 1986. In the past several years, DOE has cited numerous reasons for program slippages, including the need for a consultation process with States and Tribes, Congressional actions (e.g., the barring of funds in the 1987 budget appropriation for drilling exploratory shafts), and DOE's recognition that the EIS and license application would require more technical information than previously planned.

In the November 1989 "Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program," DOE announced a further extension of three years until 1992 for sinking the exploratory shaft, and extensions until 2001 for submittal of the license application and 2010 for repository availability. DOE attributes the causes for these delays to prolonging the schedule for site characterization and repository development activities, and to the unwillingness, to date, of the State of Nevada to issue the permits required for DOE to begin testing. In the "Reassessment Report," DOE proposes to focus the repository program on the evaluation of features of the site that can be studied through surface-based testing, beginning in January 1991. The aim of this surface-based testing program is to make an early determination as to whether there are any features of the site that would render it unsuitable for development as a repository. Of course, the site may be found unsuitable or unlicenseable at any time during the site characterization or licensing process. The NRC supports DOE's efforts to reach an early determination that this may be the case. If the Yucca Mountain site is unsuitable, it will be necessary to begin work to identify and characterize another candidate site for a repository. The sooner this determination is made, the sooner DOE will have an alternative site available for disposal of high-level waste.

The NRC had anticipated additional delays in repository program milestones when it issued its Proposed Waste Confidence Decision Review (54 FR 39767). One of the key issues in the repository program to date has been the need for DOE to develop a qualified quality assurance (QA) program. For example, DOE has taken the position, with which NRC agrees, that sinking of exploratory shafts should not occur before it has a qualified quality assurance (QA) program in place. The Commission believes that DOE's aggressive, success-oriented schedule for this milestone did not allow for unexpected developments. Indeed, the effort to develop an acceptable QA program has, in itself, identified problems in design control and other processes that must be resolved in order to establish a qualified program that addresses all applicable NRC licensing requirements. DOE has made progress in development of its QA program with seven contractor plans accepted in October and November 1989. NRC expects that DOE should be able to have the study plans and technical procedures which implement the contractor plans ready in time for surface-based testing at the Yucca Mountain site to begin by January 1991, consistent with the schedule for starting surface-based testing in the Reassessment Report.

DOE's current schedule appears to be more realistic than previous schedules. Yet even this schedule could prove unattainable due to difficulties of a non-technical nature that are outside of DOE's control, for example litigation over gaining access to the Yucca Mountain site. Although the NWPAA is a clear and strong reaffirmation of Congressional support for the timely development of a repository, the Commission in this Waste Confidence review cannot ignore the potential for delay in repository availability if the Yucca Mountain site, or any other single site designated for site characterization, is found to be unsuitable. Without alternative sites undergoing simultaneous characterization or even surface-based testing, DOE will have to begin characterizing another site if the site currently selected for characterization proves unsuitable. The earlier a determination of unsuitability can be made, the smaller the impact of such a finding would be on the overall timing of repository availability.

DOE has estimated conservatively that it would require approximately 25 years to begin site screening for a second repository, perform site characterization, submit an EIS and license applications, and await authorizations before the repository could be ready to receive waste. In its June 1987 Mission Plan amendment, DOE stated "It ... seems prudent to plan that site-specific screening leading to the identification of potentially acceptable sites should start about 25 years before the start of waste acceptance for disposal." DOE went on to say that it considered this estimate to be conservative because it does not account for expected schedular benefits from the first repository program, including improvements in such areas as site screening, site characterization, and performance assessment techniques.

Although DOE's estimate was premised on the successful completion of a program for the first of two repositories, schedular benefits from improvements in the understanding of waste isolation processes would still be available. The glass waste form from the Defense Waste Processing Facility now under construction at Savannah River, SC, for example, will be available for testing under simulated repository conditions well before the turn of the century under current DOE schedules, and improvements in the modelling of spent fuel behavior within waste canisters can be applied in performance assessments largely irrespective of the geology of a site. It may also be pertinent that when DOE made its 25-year estimate for the second repository program in mid-1987, the law at the time

required the simultaneous characterization of three sites, so that DOE could not proceed to develop one site for a repository until the completion of characterization at the site that required the most time.

In view of DOE's new schedule, it no longer appears feasible for repository operation to commence prior to 2010. As stated in the Proposed Decision Review, the Commission does not believe it would be prudent to reaffirm the Agency's 1984 finding of reasonable assurance that the 2007-2009 timetable will be met. As the Court of Appeals noted in remanding this issue to NRC, the ultimate determination of whether a disposal facility will be available when needed "...can never rise above a prediction." The Commission is in the position of having to reach a definitive finding on events which are approximately two decades away. We believe that the institutional timescale for this question can more realistically be framed in decades than in years. As the program proceeds into the next century, it will become easier for NRC to make more definitive assessments, if necessary, of the time a repository will be available.

In light of all these considerations, the Commission believes it can have reasonable assurance that at least one repository will be available within the first quarter of the twenty-first century. This estimate is based on the time it would take for DOE to proceed from site screening to repository operation at a site other than Yucca Mountain, if this should prove necessary. Assuming for the sake of conservatism that Yucca Mountain would not be found suitable for repository development, it is reasonable to expect that DOE would be able to reach this conclusion by the year 2000. This would leave 25 years for the attainment of repository operations at another site.

NRC will reassess progress towards attaining repository operation by 2025 prior to 2000 during its next scheduled review of its Waste Confidence Findings, if not sooner. DOE's current focus on surface-based testing as an early indicator of repository suitability should help provide a strong basis for evaluating the likelihood of meeting the 2025 estimate of repository availability.

II.A.2. Timely Development of Waste Packages and Engineered Barriers.

The November 1989 Reassessment Report announced that "major activities related to the design of a repository at the Yucca Mountain site and waste package are being deferred. They will be resumed when more information is available concerning the suitability of the site. This approach will conserve resources and allow the DOE to concentrate efforts on scientific investigations." Prior to the Reassessment Report, DOE's most recent conceptual design for the waste package was discussed in the Site Characterization Plan (SCP) for the Yucca Mountain site. As information is obtained from site characterization activities and laboratory studies, the conceptual design will evolve in successive stages into the Advanced Conceptual Design (ACD), the LAD, and the final procurement and construction design. DOE has identified four areas of investigation related to the waste package LAD: (1) waste package environment; (2) waste form and materials testing; (3) design, analysis, fabrication, and prototype testing; and (4) performance assessment. Numerous uncertainties exist in each of these areas. DOE's testing program will attempt to reduce uncertainties in these areas where possible. For example, *in-situ* testing is expected to decrease significantly uncertainties regarding the repository host rock mass in which the waste packages will be emplaced. In the area of performance assessment, however, where results of relatively short-term testing of complex rock-waste-ground water interactions must be extrapolated over as many as 10,000 years, it may be necessary to rely more heavily on the use of simplifying assumptions and bounding conditions than in other areas of investigation.

As discussed under Finding 1, the Commission continues to have reasonable assurance that waste packages and engineered barriers can be developed which will contribute to meeting NRC performance objectives for the repository. Development of acceptable waste packages and engineered barriers for a repository in the 2010 timeframe will depend on the overall acceptability of the Yucca Mountain site. If the site is found to be unsuitable, waste package and engineered barrier development will have to begin for a different site, because under the NWPAA, DOE may not carry out site characterization and waste package development work at sites other than the Yucca Mountain site.

Although much of the work related to waste form, materials, and performance assessment for the waste package can proceed independently of *in-situ* testing, the investigations related to waste package environment depend on the schedule for this testing. The schedule for *in-situ* testing depends on when DOE is able to resolve outstanding issues which have impeded shaft sinking and *in-situ* testing, and on DOE's being granted access to the site to begin surface-based testing.

In sum, the Commission is not aware of any scientific or technical problems so difficult as to preclude development of a waste package and engineered barrier for a repository at Yucca Mountain to be available within the first quarter of the twenty-first century. Moreover, even given the uncertainty regarding the ultimate finding of site acceptability, and the uncertainty concerning the range of site-related parameters for which the engineered facility and waste package will have to be designed, the Commission finds reasonable assurance that waste package and engineered barrier development can be completed on a schedule that would permit repository operation within the first quarter of the twenty-first century. If necessary (that is, if Yucca Mountain were found unsuitable by the turn of the century), DOE could initiate site characterization and develop waste packages and engineered barriers at another site or sites and still commence operation before the end of the first quarter of that century.

II.A.3. Institutional Uncertainties.

II.A.3.a. Measures for dealing with Federal-State-local concerns.

In its 1984 Waste Confidence Decision, the Commission found that the NWPA should help to minimize the potential that differences between the Federal Government and States and Indian tribes will substantially disrupt or delay the repository program. The Commission noted that the NWPA reduced uncertainties regarding the role of affected States and tribes in repository site selection and evaluation. The Commission also said that the decision-making process set up by the NWPA provides a detailed, step-by-step approach that builds in regulatory involvement, which should also provide confidence to States and tribes that the program will proceed on a technically sound and acceptable basis. Despite the expected and continuing State opposition to DOE siting activities, the Commission has found no institutional developments since that time that would fundamentally disturb its 1984 conclusions on this point.

NRC regulatory involvement, for example, has indeed been built into the process. DOE has continued its interactions with NRC regarding repository program activities since the Commission's 1984 Waste Confidence decision was issued. NRC provided comments to DOE on major program

documents such as the Siting Guidelines and the PDS as required by the NWPA, and NRC concurred on those documents. NRC also reviewed and provided comments to DOE on the DEAs and FEAs. In the December 22, 1986 letter to DOE on the FEAs, the NRC staff noted that "...significant efforts were made by DOE to respond to each of the NRC staff major comments on the DEAs, and in fact, many of these comments have been resolved." NRC provided comments to DOE on the 1987 Draft Mission Plan Amendment, and DOE responded to most of these comments in the Final Mission Plan Amendment provided to Congress on June 9, 1987.

Since enactment of the NWPAA in December 1987, DOE-NRC interactions have focused on the Yucca Mountain site. In January 1988, DOE issued the Consultation Draft Site Characterization Plan (CDSCP) for the Yucca Mountain site. The NRC staff provided comments in the form of draft and final "point papers" on the CDSCP. The NRC comments included several objections related to: (1) the failure to recognize the range of alternative conceptual models of the Yucca Mountain site; (2) the status of the quality assurance (QA) plans for site characterization activities; and (3) concerns related to the exploratory shaft facility. Although the December 1988 SCP shows improvement over the CDSCP, NRC continues to have an objection involving the need for implementing a baselined QA program before beginning site characterization and an objection involving the need for DOE to demonstrate the adequacy of both the ESF design and the design control process. Prior to the November 1989 Reassessment Report, DOE had committed to having a qualified QA program in place before sinking the exploratory shaft at the Yucca Mountain site.

This commitment has not changed. However, in view of the extension in the schedule for shaft sinking from November 1989 to November 1992, qualified QA plans are needed in the near term for meeting the January 1991 schedule for surface-based testing. In addition to having a qualified QA program in place, DOE must also have issued the pertinent study plans for site characterization activities they wish to begin.

DOE has taken measures to clarify and institutionalize the roles of other Federal agencies in addition to NRC. In the Draft 1988 Mission Plan Amendment, DOE described interactions with these agencies. DOE has a Memorandum of Understanding (MOU) with the Mine Safety and Health Administration of the Department of Labor for technical support and oversight for shaft construction and other site characterization activities, and with the Department of Transportation to define the respective responsibilities of the two agencies in the waste disposal program. DOE also has interagency agreements with the Bureau of Mines and the U.S. Geological Survey of the Department of the Interior.

DOE's efforts to address the concerns of States, local governments, and Indian tribes have met with mixed results. For example, DOE has not succeeded in finalizing any consultation and cooperation (C&C) agreements as required under section 117(c) of the NWPA, as amended. These agreements were to help resolve State and Tribal concerns about public health and safety, environmental, and economic impacts of a repository. Publication of the Siting Guidelines under section 112(a) of the NWPA resulted in numerous lawsuits challenging the validity of the Guidelines. Similarly, the FEAs were challenged in the Ninth Circuit by affected States and tribes.

The NWPAA did not curtail financial assistance to affected States and tribes, except to redefine and redistribute it if DOE and a State or tribe enter into a benefits agreement. The State of Nevada and affected local governments are eligible to receive financial assistance. DOE has attempted to negotiate an agreement with the State of Nevada for monetary benefits under Section 170 of the NWPAA. This Section would provide for payments of $10 million per year before receipt of spent fuel, and $20 million per year after receipt of spent fuel until closure of the repository. These payments would be in addition to certain monetary benefits for which the State is eligible under the NWPA, as amended. Also under a benefits agreement, a Review Panel would be constituted for the purpose of advising DOE on matters related to the repository, and for assisting in the presentation of State, tribal, and local perspectives to DOE. The beneficiary to a benefits agreement must waive its right to disapprove the recommendation of the site for a repository and its rights to certain impact assistance under Sections 116 and 118 of the NWPA, as amended. To date, the State of Nevada has declined DOE's offer to negotiate a benefits agreement. In 1989, the State of Nevada requested $23 million for work on Yucca Mountain. Congress appropriated $5 million and authorized DOE to release an additional $6 million at the discretion of the Secretary on the basis of good faith efforts of the State to allow technical investigations to begin at the site.

The NWPAA introduced several new organizational entities to the repository program with responsibilities that may contribute to resolving concerns of Federal, State, and local governments involved in the program. Under section 503 of the NWPAA, the Nuclear Waste Technical Review Board (NWTRB) is to evaluate the technical and scientific validity of DOE activities under the NWPAA, including site characterization and activities related to packaging or transportation of spent fuel. The NWPAA also established the Office of Nuclear Waste Negotiator, who is to seek to negotiate terms under which a State or Indian tribe would be willing to host a repository or MRS facility at a technically qualified site. Among the duties of the Negotiator is consultation with Federal agencies such as NRC on the suitability of any potential site for site characterization.

Secretary of Energy James Watkins has emphasized the importance of the Negotiator to the success of the program. A Negotiator could contribute to the timely success of the repository program by providing an alternative site to the Yucca Mountain site that would still have to be technically acceptable, but that would enjoy the advantage of reduced institutional uncertainties resulting from opposition of State or affected Indian tribes. The President nominated and the Senate recently confirmed David Leroy to be the Negotiator.

An additional measure which may facilitate documentation and communication of concerns related to a repository is the Licensing Support System (LSS). The LSS is to provide full text search capability of and easy access to documents related to the licensing of the repository. Although the primary purpose of the LSS is to expedite NRC's review of the construction authorization application for a repository, it will be an effective mechanism by which all LSS participants, including the State and local governments, can acquire early access to documents relevant to a repository licensing decision. DOE is responsible for the design, development, procurement and testing of the LSS. LSS design and development must be consistent with objectives and requirements of the Commission's LSS rulemaking and must be carried out in consultation with the LSS Administrator and with the advice of the Licensing Support System Advisory Review Panel. NRC (LSS Administrator) is responsible for the management and operation of the

LSS after completion of the DOE design and development process.

Procedures for the use of the LSS are part of revisions to 10 CFR part 2, NRC's Rules of Practice for the adjudicatory proceeding on the application to receive and possess waste at a repository. These revisions were the result of a "negotiated rulemaking" process in which affected parties meet to reach consensus on the proposed rule. The members of the negotiating committee included: DOE; NRC; State of Nevada; coalition of Nevada local governments; coalition of industry groups; and a coalition of national environmental groups. The coalition of industry groups dissented on the final text of the proposed rule, but the negotiating process enabled NRC to produce a proposed rule reflecting the consensus of most of the interested parties on an important repository licensing issue.

NRC is committed to safe disposal of radioactive waste and the protection of public health and safety and the environment. Any State with a candidate site for a repository should be assured that a repository will not be licensed if it does not meet NRC criteria. NRC has its own program for interaction with the State of Nevada and affected units of local government, and will continue to provide information to Nevada and consider State concerns as requested.

Given the difficult nature of siting a repository, the Commission believes that the NWPA, as amended, has achieved the proper balance between providing for participation by affected parties and providing for the exercise of Congressional authority to carry out the national program for waste disposal. The NWPAA provides adequate opportunity for interaction between DOE and other Federal agencies, States, tribes, and local governments such that concerns can be presented to DOE for appropriate action. Both the NRC and the State or tribe can exercise considerable prerogative regarding repository development. The State or tribe may disapprove the recommendation that the site undergo repository development. This disapproval can be overridden only by vote of both houses of Congress within 90 days of continuous session. If the State disapproval is overridden, DOE may submit an application for authorization to construct the repository, and, if approved, a subsequent application to receive and possess waste for emplacement. NRC will make decisions on the license applications according to the requirements of its statutory mission. Despite the complexity of the overall process and the strong views of the participants in it, the Commission sees no compelling reason to conclude that current institutional arrangements are inadequate to the task of resolving State, Federal, and local concerns in time to permit a repository to be available within the first quarter of the twenty-first century.

II.A.3.b. Continuity of the management of the waste program

At the time the Commission issued its 1984 Waste Confidence Decision, the possibility that DOE functions would be transferred to another Federal agency was cited as the basis for concerns that the resolution of the radioactive waste disposal problem would likely undergo further delays. The Commission responded that in the years since the Administration had proposed to dismantle DOE in September 1981, Congress had not acted on the proposal. The Commission further stated that even if DOE were abolished, the nuclear waste program would simply be transferred to another agency. The Commission did not view the potential transfer in program management as resulting in a significant loss of momentum in the waste program. The Commission also concluded that the enactment of the NWPA, which gave DOE lead responsibility for repository development, further reduced uncertainties as to the continuity of management of the waste program.

Section 303 of the NWPA did, however, require the Secretary of Energy to "...undertake a study with respect to alternative approaches to managing the construction and operation of all civilian radioactive waste facilities, including the feasibility of establishing a private corporation for such purpose." To carry out this requirement, DOE established the Advisory Panel on Alternative Means of Financing and Managing Radioactive Waste Facilities, which came to be known as the "AMFM" Panel. The Panel's final report, issued in December 1984, concluded that several organizational forms are more suited than DOE for managing the waste program, including an independent Federal agency or commission, a public corporation, and a private corporation. The report identified a public corporation as the preferred alternative on the basis of criteria developed by the Panel for an acceptable waste management organization. In particular, the report indicated that a public corporation would be stable, highly mission-oriented, able to maintain credibility with stakeholders, and more responsive to regulatory control than a Federal executive agency.

Commenting on the AMFM Panel's report in April 1985, DOE recommended retaining the present management structure of the waste program at least through the siting and licensing phase of the program. Congress did not take action to implement the Panel's recommendations, and DOE's management of the waste program has remained uninterrupted.

By enacting the NWPAA, Congress effectively reaffirmed DOE's continued management of the waste program. Congress did not revise DOE's role as the lead agency responsible for development of a repository and an MRS. Congress did establish several new entities for the purpose of advising DOE on matters related to the waste program, such as the NWTRB and the Review Panel, to be established if DOE and a State or tribe enter into a benefits agreement under Section 170 of the NWPAA. Congress provided further indication of its intent that DOE maintain management control of the waste program for the foreseeable future in requiring, under Section 161, that the Secretary of DOE "...report to the President and to Congress on or after January 1, 2007, but not later than January 1, 2010, on the need for a second repository."

This is not to say, however, that there have been no management problems in the DOE program. Since the enactment of the NWPA in 1983, only one of the five Directors of DOE's Office of Civilian Radioactive Waste Management (OCRWM) has held the position on a permanent basis. Inadequate progress toward an operating repository has concerned several Congressional observers, including Senator J. Bennett Johnston, Chairman of the Senate Energy and Natural Resources Committee. In February 1989 confirmation hearings for then-Secretary-of-Energy-designate James Watkins, Senator Johnston strongly criticized mounting cost projections and lack of progress in the program, and called for new and stronger management.

In the November 1989 Reassessment Report, DOE discussed several new initiatives for improving its management of the repository program. The initiatives include "direct-line" reporting from the Yucca Mountain Project Office to the Office of Civilian Radioactive Waste Management (OCRWM), and an independent contractor review of OCRWM management structures, systems and procedures to identify program redundancies, gaps, and

strengths. The OCRWM is also implementing improvements in the overall Program Management System, the QA program, and establishment of program cost and schedule baselines.

Whether the management structure of the repository development program should in fact be changed is a decision best left to others. The Commission believes that a finding on the likely availability of a repository should take management problems into account, but finds no basis to diminish the degree of assurance in its 1984 conclusion on this issue. Events since the submission of the AMFM Panel report do not indicate that there will be a fundamental change in the continuity of the management structure of the program any time soon. In addition, it cannot be assumed that the program would encounter significantly less difficulty with a new management structure than it would continuing under the present one. Under either scenario, however, the Commission believes it would be more prudent to expect repository operations after the 2010 timeframe than before it. Neither the problems of a new management structure nor those of the existing one are likely to prevent the achievement of repository operations within the first quarter of the next century, however.

II.A.3.c. Continued funding of the nuclear waste management program

Section 302 of the NWPA authorized DOE to enter into contracts with generators of electricity from nuclear reactors for payment of 1.0 mill (0.1 cent) per kilowatt-hour of net electricity generated in exchange for a Federal Government commitment to take title to the spent fuel from those reactors. In the 1984 Waste Confidence Decision, the Commission noted that all such contracts with utilities had been executed. After the 1984 Decision, then-President Reagan decided that defense high-level wastes are to be collocated with civilian wastes from commercial nuclear power reactors. DOE's Office of Defense Programs is to pay the full cost of disposal of defense waste in the repository.

DOE is required under Section 302(a)(4) of the NWPA, as amended, "...annually [to] review the amount of the fees...to evaluate whether collection of the fees will provide sufficient revenues to offset the costs...." In the June 1987 Nuclear Waste Fund Fee Adequacy Report, DOE recommended that the 1.0 mill per kilowatt-hour fee remain unchanged. This assessment was based on the assumption that an MRS facility would open in 1998, the first repository would open in 2003, and the second repository in 2023. These assumptions do not reflect changes in the waste program brought about by the NWPAA enacted in December 1987. Two such changes with significant potential impacts were the suspension of site-specific activities related to the second repository until at least 2007, and the linkage between MRS construction and operation and the granting of a repository construction authorization, which will probably occur no earlier than 1998.

DOE has not issued a fee adequacy report since the June 1987 report. When the updated report is released, it is expected to reflect overall program cost savings to the utilities resulting from: (1) limiting site characterization activities to a single site at Yucca Mountain, NV; and (2) the DOE Office of Defense Programs' sharing other program costs with generators of electricity "...on the basis of numbers of waste canisters handled, the portion of the repository used for civilian or defense wastes, and the use of various facilities at the repository," in addition to paying for activities solely for disposing of defense wastes. An additional factor which may eventually also contribute to the overall adequacy of Nuclear Waste Fund fees is the likelihood that a significant number of utilities will request renewals of reactor operating lifetimes beyond their current OL expiration dates. OL renewal would provide additional time during which Nuclear Waste Fund fees could be adjusted, if necessary, to cover any future increase in per-unit costs of waste management and disposal. It is expected that the new report may reflect a recent Court decision which found that fees paid into the Nuclear Waste Fund be adjusted to reflect transmission and distribution losses.

The Commission recognizes the potential for program cost increases over estimates in the 1987 Nuclear Waste Fund Fee Adequacy Report. If there is a significant delay in repository construction, for example, it is reasonable to assume that construction costs will escalate. There may also be additional costs associated with at-reactor dry cask storage of spent fuel, if DOE does not have a facility available to begin accepting spent fuel by the 1998 date specified in the NWPA. These costs would be further increased if one or more licensee was to become insolvent and DOE was required to assume responsibility for storage at affected reactors before 1998.

In the event of insolvency, DOE would still have sufficient funds to take over responsibility for managing spent fuel until a repository is available. Because spent fuel disposal costs are directly related to the amount of electricity generated, with contributions to the NWF based on a kilowatt-hour surcharge that must be paid in short-term installments, utilities can be presumed to be mostly up-to-date with their contributions. It is highly unlikely that a utility would jeopardize its contract for spent fuel disposal with DOE by defaulting on a periodic payment to save a few million dollars. Even if a utility were to default, it would not be much in arrears for its spent fuel before it would trigger close DOE scrutiny and mitigative action.

Larger amounts in default could possibly occur with those relatively few utilities that have not paid their full share of pre-1983 collections. This issue arises because several utilities elected to defer payment for spent fuel generated prior to April 1983 into the fund and, instead, themselves hold the money that was collected from ratepayers for the one-time fee. DOE's Inspector General believes that some of those utilities may not be able to make their payments when due. The NRC understands from OCRWM staff that, if a nuclear utility licensee were to default on its one-time contribution to the NWF, DOE is not precluded from accepting for disposal all spent fuel from that utility. Thus, the NRC does not view this issue as affecting its confidence that the spent fuel will be disposed of. Rather, the issue is one of equity--that is, will a utility and its customers and investors or U.S. taxpayers and/or other utilities ultimately pay for disposal of spent fuel generated prior to April 1983. The Commission does not believe that a licensee's potential default has a direct bearing on the Commission's Waste Confidence Decision.

The full impact of the program redirection resulting from the NWPAA and the outlook for the timing of repository availability will continue to be assessed annually. If it does appear that costs will exceed available funds, there is provision in the NWPA for DOE to request that Congress adjust the fee to ensure full-cost recovery. Thus, the Commission finds no reason for changing its basic conclusion that the long-term funding provisions of the Act should provide adequate financial support for the DOE program.

II.A.3.d. DOE's schedule for repository development

At the time that the 1984 Waste Confidence Decision was issued, the Nuclear Waste Policy Act of 1982, enacted in January 1983, had been in effect for less than 20 months. The NWPA had established numerous deadlines for various repository program milestones. Under section

112(b)(1)(B), the NWPA set the schedule for recommendation of sites for characterization no later than January 1, 1985. Section 114(a)(2) specified that no later than March 31, 1987, with provision for a 12-month extension of this deadline, the President was to recommend to Congress one of the three characterized sites qualified for an application for repository construction authorization. Under section 114(d), NRC was to issue its decision approving or disapproving the issuance of a construction authorization not later than January 1, 1989, or the expiration of three years after the date of submission of the application, whichever occurs later. Section 302(a)(5)(B) required that contracts between DOE and utilities for payments to the Waste Fund provide that DOE will begin disposing of spent fuel or high-level waste by January 31, 1998.

In little more than a year after enactment, the schedule established by the NWPA began proving to be optimistic. In the reference schedule for the repository presented in the April 1984 Draft Mission Plan, for example, DOE showed a slip from January 1989 to August 1993 for the decision on construction authorization.

In the 1984 Waste Confidence Decision, the Commission recognized the possibility of delay in repository availability beyond 1998, and did not define its task as finding confidence that a repository would be available by the 1998 milestone in the NWPA. The Commission focused instead on the question of whether a repository would be available by the years 2007-2009, the date cited in the court remand as the expiration of the OLs for the Vermont Yankee and Prairie Island reactors. The NRC believed that the NWPA increased the chances for repository availability within the first few years of the twenty-first century, by specifying the means for resolving the institutional and technical issues most likely to delay repository completion, by establishing the process for compliance with NEPA, and by setting requirements for Federal agencies to cooperate with DOE in meeting program milestones. Finding that no fundamental technical breakthroughs were necessary for the repository program, the Commission predicted that "...selection and characterization of suitable sites and construction of repositories will be accomplished within the general time frame established by the Act [1998] or within a few years thereafter."

In January 1987, DOE issued a Draft Mission Plan Amendment to apprise Congress of significant developments and proposed changes in the repository program. In the Draft Amendment, DOE announced a five-year delay in its schedule for repository availability from the first quarter of 1998 to the first quarter of 2003. DOE's reasons for the delay included the need for more time for consultation and interaction with States and Tribes, the requirement in DOE's 1987 budget that funds not be used for drilling exploratory shafts in 1987, and the need for more information than previously planned for site selection and the license application. The 1987 Draft Mission Plan Amendment set the second quarter of 1988 as the new date for exploratory shaft construction at the Yucca Mountain site. When the final 1987 Mission Plan Amendment was submitted to Congress in June 1987, the schedule for shaft sinking at the Yucca Mountain site had slipped six months to the fourth quarter of 1988. Congress did not take action to approve the June 1987 Mission Plan Amendment as DOE had requested.

On December 22, 1987, the NWPAA was enacted. The NWPAA had its major impact on the repository program in suspending site characterization activities at the Hanford and Deaf Smith County sites and authorizing DOE to characterize the Yucca Mountain site for development of the first repository.

DOE subsequently issued the Draft 1988 Mission Plan Amendment in June 1988, to apprise Congress of its plans for implementing the provisions of the NWPAA. In the Draft 1988 Mission Plan Amendment, DOE's schedule for shaft sinking at Yucca Mountain had slipped another six months to the second quarter of 1989. Since the NRC published the Proposed Waste Confidence Review (54 FR 39767) for comment, the schedule for shaft sinking has been changed from November 1989 to November 1992. Issues requiring DOE attention before site characterization can begin have been identified, and it is possible that additional issues affecting DOE's readiness will come to light. However, DOE has made progress in completing QA plans since September 1989, and it is reasonable to expect that study plans and technical procedures needed for surface-based testing will be ready in time for testing to begin by January 1991.

Heretofore, the repository schedule has always been agressive and highly success-oriented. In comments on the Draft 1988 Mission Plan Amendment, the Commission noted that the schedule has not allowed adequately for contingencies, and that, given the compression in the schedule for near-term program milestones, DOE had not shown how it would be able to meet the 2003 milestone for repository operation. The revised schedule announced in the November 1989 Reassessment Report includes a new reference schedule for the restructured repository, MRS, and transportation programs. Under the restructured program, the schedule for submittal of a construction authorization application to NRC has been extended from 1995 to 2001, and the schedule for repository operation at Yucca Mountain, if that site is found to be suitable, is 2010. DOE believes that this reference schedule is the first repository program schedule since passage of the NWPA that is based on a "realistic assessment of activity duration and past experience." The new schedule allows more time for scientific investigations than earlier schedules. NRC believes that the restructured program has been responsive to NRC concerns that the quality and completeness of site investigations were being compromised in order to satisfy unrealistic schedule requirements.

Another potential source of delay in repository availability may arise from NRC regulations. Given the revised schedule, however, the NRC does not believe this is likely. The Commission believes that current NRC rules are fully adequate to permit DOE to proceed to develop and submit a repository license application, but further clarification of these rules is desirable to reduce the time needed to conduct the licensing proceeding itself. In order to meet the three-year schedule provided in the NWPA for a Commission decision on repository construction authorization, the NRC staff has undertaken to refine its regulatory framework on a schedule that would permit DOE to prepare and submit an application for repository construction authorization under its current schedule. The Commission fully intends to avoid delaying DOE's program, while working to reduce the uncertainties in NRC regulatory requirements that could become contentions in the licensing proceeding. Even if there are any delays resulting from a need for DOE to accommodate more specific regulatory requirements in its site characterization or waste package development programs, the Commission is confident that the time savings in the licensing proceeding will more than compensate for them.

In view of the delays in exploratory shaft excavation since the 2003 date for repository availability was set, the Commission believed it was optimistic to expect that Phase 1 of repository operations would be able to begin by

2003. As DOE's schedule for repository availability has slipped a year and a half since the date was changed from 1998 to 2003, the earliest date for repository availability would probably be closer to 2005. Given additional delays in shaft sinking and DOE's revised program schedule, NRC believes that 2010 is the earliest date for repository availability at Yucca Mountain. Yet, the Commission recognizes that DOE is committed to improving the schedule where possible without sacrificing quality and completeness of scientific investigations.

An institutional issue that may further affect DOE's schedule is the status of EPA standards for disposal of spent fuel and high-level waste. These standards are required under section 121(a) of the NWPA. Under 10 CFR section 60.112, NRC's overall postclosure system performance objective, the geologic setting shall be selected and the engineered barrier system, which includes the waste package, must be designed to assure that releases of radioactive materials to the accessible environment, following permanent closure, conform to EPA's standards. 40 CFR part 191, the EPA standards, first became effective in November 1985. In July 1987, the U.S. Court of Appeals for the First Circuit vacated and remanded to EPA for further proceedings subpart B of the high-level radioactive waste disposal standards. As noted under the aforementioned I.A.1., the standards have not been reissued.

A significant modification in the reissued EPA standard may affect the schedule for completing the design of the waste package and engineered barrier to the extent that design testing is planned to demonstrate compliance with the standards. DOE's current site characterization plans for demonstrating compliance with 40 CFR part 191 are based on the standards as promulgated in 1985. DOE is proceeding to carry out its testing program developed for the original EPA standards. DOE has stated that if the EPA standards are changed significantly when they are reissued, DOE will reevaluate the adequacy of its testing program.

The Commission believes that DOE's approach is reasonable. Much of the information required to demonstrate compliance with the EPA standards is expected to remain the same regardless of the numerical level at which each standard is set. Considering the importance of developing the repository for waste disposal as early as safely practicable, it would be inappropriate for DOE to suspend work on development of engineered barriers pending reissuance of the standards, unless EPA had given clear indications of major changes in them.

Another possibility is that, regardless of any changes in the repromulgated EPA standards, they will be litigated in Federal court. Even if this proves to be the case, however, the Commission believes that any such litigation will still permit EPA to promulgate final standards well within the time needed to enable DOE to begin repository operations at any site within the first quarter of the twenty-first century.

Given the current DOE program schedule, and assuming that the QA program can be qualified and surface-based testing begun within the next year, the Commission finds that although it is not impossible that a repository at Yucca Mountain will be available by 2007-2009, it is more likely that the earliest date for a repository there is 2010. If DOE determines that the Yucca Mountain site is unsuitable, and if DOE makes this determination by the year 2000, the NRC believes that a repository at another site could be available within the first quarter of the next century. The Commission will reevaluate these dates during the next scheduled Waste Confidence Review in 1999.

II.B. Relevant Issues That Have Arisen since the Commission's Original Decision

II.B.1. NRC stated in 9-14-87 correspondence to Sen. Breaux on pending nuclear waste legislation that under a program of single site characterization, "...there may be a greater potential for delay of ultimate operation of a repository than there is under the current regime where three sites will undergo at-depth characterization before a site is selected." To what extent does the NWPAA raise uncertainty about the identification of a technically acceptable site and potential delay in repository availability by limiting site characterization to a single candidate site (Yucca Mt.) and by raising the possibility that a negotiated agreement might influence repository site selection? Does this uncertainty affect confidence in the availability of a repository by 2007-2009?

In providing comments to Congress on proposed amendments to the NWPA, NRC took the position that simultaneous site characterization of three sites, as required by the NWPA, was not necessary to protect public health and safety. NRC further stated that the adequacy of a site for construction authorization would ultimately be determined in a licensing proceeding, and that NRC would only license a site that satisfied NRC licensing requirements. As described next, the Commission believes that the NWPAA contains numerous provisions to ensure that a technically acceptable site will be identified.

The NWPAA does not reduce the scope of site characterization activities that DOE is authorized to undertake. The Amendments Act establishes a Nuclear Waste Technical Review Board composed of individuals recommended by the National Academy of Sciences and appointed by the President to evaluate the scientific validity of DOE activities, including site characterization activities, and to report its findings at least semiannually to Congress and DOE. The Amendments Act also provides funding for technical assistance to States, tribes, and affected units of local government. Finally, section 160(l) of the NWPAA provides that "Nothing in this Act shall be construed to amend or otherwise detract from the licensing requirements of the NRC established in Title II of the Energy Reorganization Act of 1974 (42 U.S.C. 5841 et seq.)." In providing for these reviews and in reaffirming NRC's licensing authority, the NWPAA ensures that a candidate site for a repository must satisfy all NRC requirements and criteria for disposal of high-level radioactive wastes in licensed geologic repositories.

Section 402 of the NWPAA establishes the Office of the Nuclear Waste Negotiator. The duty of the Negotiator is to attempt to find a State or tribe willing to host a repository or MRS at a technically qualified site. The Negotiator may solicit comments from NRC, or any other Federal agency, on the suitability of any potential site for site characterization. Section 403(d)(4) strengthens the Commission's confidence that a technically acceptable site will be identified by providing that DOE may construct a repository at a negotiated site only if authorized by NRC. Given these safeguards on selection of a technically acceptable site, the Commission does not consider that the possibility of a negotiated agreement reduces the likelihood of finding a technically qualified site.

The Commission raised the concern as early as April 1987 that under a program of single-site characterization, there could be considerable delay while

characterization was completed at another site or slate of sites if the initially chosen site was found inadequate. By terminating site characterization activities at alternative sites to the Yucca Mountain site, the NWPAA has had the effect of increasing the potential for delay in repository availability if the Yucca Mountain site proves unsuitable. The provision in the NWPAA for a Negotiator could reduce the uncertainty and associated delay in restarting the repository program by offering an alternate to the Yucca Mountain site; but at the time of this writing, a Negotiator has not been appointed.

It should be noted here that the repository program redirection under the NWPAA does not, *per se*, have a significant impact on the Commission's assurance of repository availability by 2007-2009, the relevant dates in the original Waste Confidence Proceeding, or on availability by 2010, DOE's current date. The Commission's reservations about affirming this timeframe derive from other considerations, including delays in sinking shafts and the potential for other delays in meeting program milestones, that would have arisen without the NWPAA.

The Amendments Act does, however, effectively make it necessary that Yucca Mountain be found suitable if the 2007-2009 or 2010 timeframe is to be met; this target period would almost certainly be unachievable if DOE had to begin screening to characterize and license another site. Thus, confidence in repository availability in this period would imply confidence in the suitability of Yucca Mountain. The Commission does not want its findings here to constrain in any way its regulatory discretion in a licensing proceeding. Therefore, the Commission declines to reaffirm the 2007-2009 timeframe in the original decision or to affirm the current 2010 date for repository operation.

II.B.2. In the Draft 1988 Mission Plan Amendment, DOE stated that "...the

data indicate that the Yucca Mountain site has the potential capacity to accept at least 70,000 MTHM [metric tons heavy metal equivalent] of waste, but only after site characterization will it be possible to determine the total quantity of waste that could be accommodated at this site."

a. Do the issues of limited spent fuel capacity at Yucca Mountain, indefinite suspension of the second repository program, and the likelihood that no more than one repository will be available by 2007-2009 undermine the NRC's 1984 assurance that "sufficient repository capacity will be available within 30 years beyond expiration of any reactor operating license to dispose of existing commercial high level radioactive waste and spent fuel originating in such reactor and generated up to that time?"

b. Is there sufficient uncertainty in total spent fuel projections (e.g., from extension-of-life license amendments, renewal of operating licenses for an additional 20 to 30 years, or a new generation of reactor designs) that this Waste Confidence review should consider the institutional uncertainties arising from having to restart a second repository program?

II.B.2.a. Although it will not be possible to determine whether Yucca Mountain can accommodate 70,000 MTHM or more of spent fuel until after site characterization, the Commission does not believe that the question of repository capacity at the Yucca Mountain site should be a major factor in the analysis of Finding 2. This is because it cannot be assumed that Yucca Mountain will ultimately undergo development as a repository. The generic issue of repository capacity does add to the potential need for more than one repository, however.

As noted earlier, the NWPA established deadlines for major milestones in the development of the first and the second repository programs. The Act also required NRC to issue a final decision on the construction authorization application by January 1, 1989 for the first repository, and January 1, 1992 for the second (or within three years of the date of submission of the applications, whichever occurred later). The July 1984 Draft DOE Mission Plan set January 1998 and October 2004 as the dates for commencement of waste emplacement in the first and second repositories, assuming that Congressional authorization was obtained to construct the second repository.

Thus, at the time the 1984 Waste Confidence Decision was issued, DOE was authorized and directed to carry out two repository programs under a schedule to make both facilities operational by 2007-2009. DOE and NRC were also working under the constraint, still in force under the NWPA as amended, that no more than 70,000 MTHM may be emplaced in the first repository before the second is in operation. Because DOE estimated at the time that commercial U.S. nuclear power plants with operating licenses or construction permits would discharge a total 160,000 MTHM of spent fuel, it appeared that at least two repositories would be needed.

In the 1984 Waste Confidence Decision, reactors were assumed to have a 40-year operating lifetime, and because the earliest licenses were issued in 1959 and the early 1960's, the oldest plants' licenses were due to expire as early as 1999 and 2000, as discussed in more detail below. Although it was expected that at least one repository would be available by this time, there was also a limit as to how quickly spent fuel could be accepted by the repository. DOE had estimated that waste acceptance rates of 3400 MTHM per year could be achieved after the completion of Phase 2 of the first repository. This rate could essentially double if two repositories were in operation. At 6000 MTHM/year, it was estimated that all the anticipated spent fuel could be emplaced in the two repositories by about the year 2026. This was the basis for the Commission's position that sufficient repository capacity would be available within 30 years beyond expiration of any reactor OL to dispose of existing commercial high level waste and spent fuel originating in such reactor and generated up to that time.

In May 1986, however, DOE announced an indefinite postponement of the second repository program. The reasons for the postponement included decreasing forecasts of spent fuel discharges, as well as estimates that a second repository would not be needed as soon as originally supposed. With enactment of the NWPAA in December 1987, DOE was required to terminate all site-specific activities with respect to a second repository unless such activities were specifically authorized and funded by Congress. The NWPAA required DOE to report to Congress on the need for a second repository on or after January 1, 2007, but not later than January 1, 2010.

Current DOE spent fuel projections, based on the assumption of no new reactor orders, call for 87,000 MTHM to have been generated by the year 2036, including approximately 9000 MTHM of defense high-level waste. With the likelihood that there will be reactor lifetime extensions and renewals, however, the no-new-orders case probably underestimates total spent fuel discharges. Also, the NWPAA did not change the requirement that no more

than 70,000 MTHM could be emplaced in the first repository before operation of the second. It therefore appears likely that two repositories will be needed to dispose of all the spent fuel and high-level waste from the current generation of reactors, unless Congress provides statutory relief from the 70,000 MTHM limit, and the first site has adequate capacity to hold all of the spent fuel and high-level waste generated. The Commission believes that if the need for an additional repository is established, Congress will provide the needed institutional support and funding, as it has for the first repository.

For all but a few licensed nuclear power reactors, OLs will not expire until some time in the first three decades of the twenty-first century. Several utilities are currently planning to have their OLs renewed for ten to 30 years beyond the original license expiration. At these reactors, currently available spent fuel storage alternatives effectively remove storage capacity as a potential restriction for safe operations. For these reasons, a repository is not needed by 2007-2009 to provide disposal capacity within 30 years beyond expiration of most OLs. If work is begun on the second repository program in 2010, the repository could be available by 2035, according to DOE's estimate of 25 years for the time it will take to carry out a program for the second repository. Two repositories available in approximately 2025 and 2035, each with acceptance rates of 3400 MTHM/year within several years after commencement of operations, would provide assurance that sufficient repository capacity will be available within 30 years of OL expiration for reactors to dispose of the spent fuel generated at their sites up to that time.

There are several reactors, however, whose OLs have already expired or are due to expire within the next few years, and which are now licensed or will be licensed only to possess their spent fuel. If a repository is not available until about 2025, these reactors may be exceptions to the second part of the Commission's 1984 Finding 2, which was that sufficient repository capacity will be available within 30 years beyond the expiration of any reactor OL to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time.

The basis for this second part of Finding 2 has two components: (1) a technical or hardware component; and (2) an institutional component. The technical component relates to the reliability of storage hardware and engineered structures to provide for the safe storage of spent fuel. An example would be the ability of spent fuel assemblies to withstand corrosion within spent fuel storage pools, or the ability of concrete structures to maintain their integrity over long periods. In the 1984 Decision, the Commission found confidence that available technology could in effect provide for safe storage of spent fuel for at least 70 years.

The Commission's use of the expression "30 years beyond expiration of any reactor operating license" in the 1984 Finding was based on the understanding that the license expiration date referred to the scheduled expiration date at the time the license was issued. It was also based on the understanding that, in order to refuel the reactor, some spent fuel would be discharged from the reactor within twelve to eighteen months after the start of full power operation.

Thus, the Commission understood that, depending on the date of the first reactor outage for refueling, some spent fuel would be stored at the reactor site for most of the 40-year term of the typical OL. In finding that spent fuel could be safely stored at any reactor site for at least 30 years after expiration of the OL for that reactor, the Commission indicated its expectation that the total duration of spent fuel storage at any reactor would be about 70 years.

Taking the earliest licensed power reactor, the Dresden 1 facility licensed in 1959, and adding the full 40-year operating license duration for a scheduled license expiration in the year 1999, the Commission's finding would therefore entail removal of all spent fuel from that reactor to a repository within the succeeding 30 years, or by 2029. Even if a repository were not available until the end of the first quarter of the twenty-first century, DOE would have at least four years to ship the reactor's 663 spent fuel assemblies, totalling 70 metric tons initial heavy metal (MTIHM), from Dresden 1 without exceeding the Commission's 30-year estimate of the maximum time it would take to dispose of the spent fuel generated in that reactor up to the time its OL expired. (MTIHM is a measure of the mass of the uranium in the fuel (or uranium and plutonium if it is a mixed oxide fuel) at the time the fuel is placed in the reactor for irradiation.)

Considering the experience from the 1984 and 1985 campaigns to return spent fuel from the defunct West Valley reprocessing facility to the reactors of origin, 70 metric tons of BWR spent fuel can easily be shipped within four years. The first campaign, involving truck shipments of 20 metric tons from West Valley, NY, to Dresden 1 in Morris, IL, took eleven months. The second, involving truck shipments of 43 tons from West Valley to the Oyster Creek reactor in Toms River, NJ, took six months. (See *Case Histories of West Valley Spent Fuel Shipments*, Final Report, NUREG/CR-4847 WPR-86(6811)-1, p. 2-2.) This estimate assumes, moreover, that no new transportation casks, designed to ship larger quantities of older, cooler spent fuel, for example, would be available by 2025.

The institutional part of the question concerning the availability of sufficient repository capacity required the Commission to make a finding as to whether spent fuel in at-reactor storage would be safely maintained after the expiration of the facility OL. This question related to the financial and managerial capability for continued safe storage and monitoring of spent fuel, rather than to the capability of the hardware involved. The Commission determined, in Finding 3 of its 1984 Decision, that spent fuel will be managed in a safe manner until sufficient repository capacity is available to assure safe disposal, which was expected under Finding 2 to be about 30 years after the expiration of any reactor OL. (See discussion of Finding 3 below for additional discussion of the institutional aspects of spent fuel storage pending the availability of sufficient disposal capacity.)

The availability of a repository within the first quarter of the twenty-first century holds no significant adverse implications for the Commission's institutional concern that there be an organization with adequate will and wherewithal to provide continued long-term storage after reactor operation. This could be a concern if a significant number of reactors with significant quantities of spent fuel onsite were to discontinue operations indefinitely between now and 1995, and the utility-owners of these reactors did not appear to have the resources to manage them safely for up to 30 years pending the assumed availability of a repository in 2025.

No such development is likely. No licenses for currently operating commercial nuclear reactors are scheduled to expire until the year 2000, and most such licenses will expire during the first two decades after 2006. (See *Nuclear Regulatory Commission 1989 Information Digest*, NUREG-1350, Vol. 1, p. 33.) The availability of the first repository by 2025, and of a second repository within one or two decades

thereafter, would provide adequate disposal capacity for timely removal of the spent fuel generated at these reactors.

There are several licensees, however, whose authority to operate their commercial reactors has already been terminated. These are Indian Point 1, Dresden 1, Humboldt Bay, and Lacrosse. They are also the only licensed power reactors that are retired with spent fuel being stored onsite. Assuming conservatively that a repository does not become operational until 2025, it appears likely that spent fuel will remain at these sites for more than 30 years beyond the time their reactors were indefinitely shut down, at which point their operating licenses could be considered to have effectively expired, although they will continue to hold a possession license for the storage of the spent fuel.

In considering the means and motivation of the owner of an indefinitely retired reactor to provide safe long-term storage, the Commission believes it is useful to distinguish between the owner with only one reactor, and the owner of a reactor at a multi-unit site or an owner with operating reactors at other sites. In the case of a retired reactor at a multi-unit site, the owner would have a clear need to maintain the safety of storage at the retired reactor sufficiently to permit continued generation at the site. If the owner of the retired reactor also owned other reactors at other sites, the spent fuel at the retired reactor could be transferred, if necessary, to the storage facilities of other units still under active management. Of the four reactors just cited, Indian Point 1 and Dresden 1 fit this description, and the sibling reactors at their sites are operating under licenses that do not expire until well beyond the year 2000--that is, well within the post-OL period during which the Commission has found that spent fuel could be safely stored pending the availability of a repository.

For the Lacrosse and Humboldt Bay reactors, the Commission is confident that, even if a repository is not available within 30 years following their retirement, the overall safety and environmental acceptability of extended spent fuel storage will also be maintained for these exceptional cases. Because there will still be an NRC possession license for the spent fuel at these facilities, the Commission will retain ample regulatory authority to require any measures, such as removal of the spent fuel remaining in storage pools to passive dry storage casks, that might become necessary until the time that DOE assumes title to the spent fuel under contracts pursuant to the NWPA. It should also be borne in mind that Humboldt Bay and Lacrosse are both small early reactors, and their combined spent fuel inventory totals 67 metric tons of initial heavy metal. (See *Spent Fuel Storage Requirements* (DOE/RL 88-34) October 1988, Table A.3b., pp. A.15-A.17.) If for any reason not now foreseen, this spent fuel can no longer be managed by the owners of these reactors, and DOE must assume responsibility for its management earlier than currently planned, this quantity of spent fuel is well within the capability of DOE to manage onsite or offsite with available technology.

Nor does the Commission see a significant safety or environmental problem with premature retirements of additional reactors. In the Commission's original Waste Confidence Decision, it found reasonable assurance that spent fuel would have to spend no more than 30 years in post-operational storage pending the availability of a repository. For a repository conservatively assumed to be available in 2025, this expected 30-year maximum storage duration remains valid for most reactors, and would be true for all reactors that were prematurely retired after 1995. Based on the past history of premature shutdowns, the Commission has reason to believe that their likely incidence during the next six years will be small as a proportion of total reactor-years of operation.

Historically, 14 of the 125 power reactors that have operated in the U.S. over the past 30 years have been retired before the expiration of their operating licenses. These early retirements included many low-power developmental reactors, which may make the ratio of 14 to 125 disproportionately high as a basis for projecting future premature shutdowns.

The Commission is aware of currently operating reactors that may be retired before the expiration of their OLs, including: the recently-licensed Shoreham reactor, which has generated very little spent fuel; the Fort St. Vrain high-temperature gas-cooled reactor, which its owner plans to decommission; and the Rancho Seco reactor, which has operated for the past 12 years and may or may not be retired. Assuming that these and perhaps a few more reactors do retire in the next several years, their total spent fuel storage requirements would not impose an unacceptable safety or environmental problem, even in the unlikely event that all these reactors' owners were rendered financially or otherwise unable to provide adequate care, and DOE were required to assume custody earlier than currently envisioned under the NWPA.

Licensed non-power research reactors provide an even more manageable case. DOE owns the fuel for almost all of these reactors, many of which have been designed with lifetime cores that do not require periodic refueling. For those reactors that do discharge spent fuel, DOE accepts it for storage or reprocessing, and not more than an estimated 50 kilograms of such spent fuel are generated annually.

Thus, given these worst-case projections, which are not expectations but bounding estimates, the Commission finds that a delay in repository availability to 2025 will not result in significant safety or environmental impacts due to extended post-operational spent fuel storage. To put it another way, the Commission is confident that, even if a repository were not available within 30 years after the effective expiration of the OLs for both currently retired reactors and potential future reactor retirements through 1995, the overall safety and environmental impacts of extended spent fuel storage would be insignificant.

II.B.2.b. Although it is clear that there is uncertainty in projections of total future spent fuel discharges, it is not clear that the institutional uncertainties arising from having to restart a second repository program should be considered in detail in the current Waste Confidence Decision review.

License renewals would have the effect of increasing requirements for spent fuel storage. The Commission understands that some utilities are currently planning to seek renewals for 30 years. Assuming for the sake of establishing a conservative upper bound that the Commission does grant 30-year license renewals, the total operating life of some reactors would be 70 years, so that the spent fuel initially generated in them would have to be stored for about 100 years if a repository were not available until 30 years after the expiration of their last OLs.

Even under the conservative bounding assumption of 30-year license renewals for all reactors, however, if a repository were available within the first quarter of the twenty-first century, the oldest spent fuel could be shipped off the sites of all currently operating reactors well before the spent fuel initially generated in them reached the age of 100 years. Thus, a second repository, or additional capacity at the first, would be needed only to accommodate the additional quantity of spent fuel generated during the later years of these reactors'

operating lives. The availability of a second repository would permit spent fuel to be shipped offsite well within 30 years after expiration of these reactors' OLs. The same would be true of the spent fuel discharged from any new generation of reactor designs.

In sum, although some uncertainty in total spent fuel projections does arise from such developments as utilities' planning renewal of OLs for an additional 20 to 30 years, the Commission believes that this Waste Confidence review need not at this time consider the institutional uncertainties arising from having to restart a second repository program. Even if work on the second repository program is not begun until 2010 as contemplated under current law, there is sufficient assurance that a second repository will be available in a timeframe that would not constrain the removal of spent fuel from any reactor within 30 years of its licensed life for operation.

II.B.3. Are early slippages in the DOE repository program milestones

significant enough to affect the Commission's confidence that a repository will be available when needed for health and safety reasons?

The 2007-2009 timeframe imposed on the Commission by the May 23, 1979 remand by the Court of Appeals was based on the scheduled expiration of the OLs for the Vermont Yankee and Prairie Island nuclear reactors. The specific issues remanded to the Commission were: (1) whether there is reasonable assurance that an offsite storage solution will be available by the years 2007-2009 (the expiration of the plants' operating licenses); and, if not, (2) whether there is reasonable assurance that the fuel can be stored safely at the sites beyond those dates.

There was no finding by the Court that public health and safety required offsite storage or disposal by 2007-2009. In directing the Commission to address the safety of at-reactor storage beyond 2007-2009, the Court recognized the possibility that an offsite storage or disposal facility might not be available by then.

The Commission has not identified a date by which a repository must be available for health and safety reasons. Taking into account institutional requirements for spent fuel storage, the Commission found, under Finding 3 in the 1984 Waste Confidence Decision, that spent fuel would be safely managed until sufficient repository capacity is available. The Commission also found, however, that in effect, under the second part of Finding 2, safe management would not need to continue for more than 30 years beyond expiration of any reactor's OL, because sufficient repository capacity was expected to become available within those 30 years. Considering that spent fuel would not have to be stored more than 30 years after any reactor's 40-year OL expiration, and taking into account the technical requirements for such storage, the Commission went on to determine under Finding 4 that, in effect, spent fuel could be safely stored for at least 70 years after discharge from a reactor. Thus, the Commission's 1984 Decision did not establish a time when sufficient repository capacity would be required; it established a minimum period during which storage would continue to be safe and environmentally acceptable pending the expected availability of sufficient repository capacity.

Bearing in mind that reactor facilities were originally designed and OLs issued for a licensed life for operation of 40 years, the Commission is proposing elsewhere in this Federal Register notice a clarifying revision of Finding 4 to say that spent fuel can be safely stored at a reactor for at least 30 years after the "licensed life for operation" of that reactor. Implicitly, the proposed use of the phrase "licensed life for operation" clarifies that the Commission found in 1984 that NRC licensing requirements for reactor facility design, construction, and operation provide reasonable assurance that spent fuel can be stored safely and without significant environmental impacts for at least the first 40 years of the reactor's life. The Commission's proposed finding also implies that, barring any significant and pertinent unexpected developments, neither technical nor institutional constraints would adversely affect this assurance for at least another 30 years after that first 40 years. Another implication of this revised finding is that, where a utility is able to meet NRC requirements to extend that reactor's operating lifetime by license renewal, spent fuel storage for at least 30 years beyond the end of the period of extended life will also be safe and without significant environmental impacts.

In assessing the effect of early slippages in DOE repository program milestones, therefore, the most important consideration is not the earliest date that an operating license actually expired, but the earliest date that an OL was issued. The earliest OL to be issued was for Dresden 1 in 1959, followed by a number of reactors licensed for operation in 1962. The OLs for all of the 111 power reactors now licensed to operate are currently scheduled to expire sometime within the first three decades of the twenty-first century, which is also the period in which their currently licensed life for operation would end. (See *Nuclear Regulatory Commission 1989 Information Digest*, NUREG-1350, Vol. 1, p. 33.) Thus, conservatively assuming here that there will be no license renewals, the earliest timeframe when a repository might be needed to dispose of spent fuel from the majority of reactors is 2029-2050.

As proposed in the first part of Finding 2, the Commission has reasonable assurance that a repository will be available within the first quarter of the twenty-first century. Even if a repository were not available until 2025, this would be several years before the beginning of the earliest timeframe within which, based on an assumed 30-year storage after an assumed 40-year licensed life of reactor operation, a repository might be needed for spent fuel disposal. Thus, early slippages in DOE's program milestones do not affect the Commission's confidence that a repository will be available within that timeframe.

II.B.4. NRC has stated that the 3- to 4-year license application review schedule is optimistic, and that for NRC to meet this schedule, DOE must submit a complete and high-quality license application. In the September 16, 1988 NRC comments to DOE on the Draft 1988 Mission Plan Amendment, the Commission requested that DOE acknowledge its commitment to develop this complete and high-quality application, "even if this would result in longer times to collect the necessary information and subsequent delays in submitting the license application."

Will NRC's emphasis on the completeness and quality of the license application have a significant effect on the timing of the submittal of the license application and subsequent licensing proceeding to grant construction authorization in time for repository availability by 2007-2009?

As the NRC indicated to DOE in NRC's October 25, 1985 comments on the draft PDS, the three-year statutory schedule for the NRC licensing proceeding on the application for construction authorization is optimistic. The Commission has sought ways to improve the prospects for meeting this schedule, for example by developing the LSS for expedited document discovery during the licensing proceeding.

In the same correspondence on the PDS, NRC also stated that the adequacy of the three-year review period depends

on DOE's submittal of a complete and high-quality application. A license application supported by inadequate data may lead to findings during the licensing proceeding that the results of certain tests cannot be admitted as part of the license application. If it is not possible to repeat the tests in question, NRC may have no alternative but to deny the application—with a consequent loss of program momentum and considerable financial cost.

In the November 1989 Reassessment Report, DOE announced extensions in all major repository program milestones. The current target date for repository availability is 2010. In a speech before the 1989 Nuclear Energy Forum, W. Henson Moore, Deputy Secretary of Energy, stated that a permanent repository at Yucca Mountain could not be operational before 2010, under optimum circumstances. The 2010 at-the-earliest timeframe falls outside of the 2007-2009 timeframe for an "offsite storage solution" in the 1979 Court remand which precipitated the NRC's Waste Confidence Proceeding. In the Reassessment Report, DOE noted that in developing its current schedule, certain activities, one of which was NRC's review of the license application, were outside of DOE's control. However, DOE also stated that it would continue its ongoing interactions with NRC and EPA "to reduce the number of unresolved issues remaining at the time of licensing, which should enhance confidence that the license application can be reviewed in three years, as called for in the Nuclear Waste Policy Act." The NRC does not believe that it is likely that NRC's emphasis on completeness and quality of the license application will contribute to substantial delays in submitting the license application and in the licensing proceeding that would delay repository availability much beyond 2010 at the Yucca Mountain site.

In any case, the Commission remains convinced that the benefits to the repository program of submitting a high-quality license application would outweigh the cost of delay in preparing the application. NRC has always placed great emphasis on early resolution of potential licensing issues in the interest of expeditious review of the license application and timely repository availability. It is in the same spirit of timely repository operation that the Commission is urging greater attention to quality than to meeting the schedule for submittal of the license application. NRC believes that a complete and high-quality license application offers the best available assurance that timely repository licensing and operation can be achieved.

In addition to expediting the review of the application, a high-quality license application and site characterization program should enhance overall confidence that any site granted a construction authorization will prove to be reliable during the period of performance confirmation. It will also increase public confidence that the program is being carried out in a thorough and technically sound manner.

II.C. Conclusion on Finding 2

In reexamining the technical and institutional uncertainties surrounding the timely development of a geologic repository since the 1984 Waste Confidence Decision, the Commission has been led to question the conservatism of its expectation that a repository would be available by 2007-2009.

At the time of the 1984 Decision, the Commission said that timely attainment of a repository did not require DOE to adhere strictly to the milestones set out in the NWPA, and there would be delays in some milestones. It did not appear to the Commission at the time that delays of a year or so in meeting any of the milestones would delay the date of repository availability by more than a few years beyond the 1998 deadline specified in the Act.

Since then, however, several developments have made it apparent that delays of more than a few years are to be the norm rather than the exception in the early years of this program. There has been a twelve-year slip in DOE's estimate of repository availability from 1998 to 2010, and DOE has been unable to meet such near-term repository program milestones as excavation of the exploratory shaft and the start of in-situ testing. There remains the possibility that potential repository availability at the Yucca Mountain site will be further delayed due to unforeseen problems during site characterization.

In predicting the timing of repository availability, the suitability of Yucca Mountain should not be assumed. Yucca Mountain is now the only candidate site available; the NWPAA required that DOE terminate site characterization activities at all sites other than the Yucca Mountain site. In effect, the 2007-09 schedule for repository availability in the original Waste Confidence Decision could have been met only if Yucca Mountain survived the repository development process as a licensed site without major delays in site characterization and licensing. If this site were found to be unlicenseable or otherwise unsuitable, characterization would have to begin at another site or suite of sites, with consequent further delay in repository availability. The final decision on the suitability of the site to proceed to licensing and repository development will rest with DOE, but the position of the NRC staff will figure in that decision. The staff will not be able to make a recommendation to a licensing board to authorize repository construction at Yucca Mountain until all site characterization activities have been completed. DOE might thus be unable for several more years to determine whether there will in fact have to be a delay to find and characterize another site.

Another reason the Commission is unwilling to assume the suitability of Yucca Mountain is that NRC must be mindful of preserving all its regulatory options—including a recommendation of license application denial—to assure adequate protection of public health and safety from radiological risk. In our view, it is essential to dispel the notion that for schedular reasons there is no alternative to the currently preferred site. This view is consistent with past Commission statements that the quality of DOE's preparations for a license application should take precedence over timeliness where the two conflict. It is also consistent with the view that because we are making predictions about completion dates for a unique and complex enterprise at least some 20 years hence, it is more reasonable to express the timescale for completion in decades rather than years.

In order to obtain a conservative upper bound for the timing of repository availability, the Commission has made the assumption that the Yucca Mountain site will be found to be unsuitable. If DOE were authorized to initiate site screening for a repository at a different site in the year 2000, the Commission believes it reasonable to expect that a repository would be available by the year 2025. This estimate is based on the DOE position that site screening for a second repository should begin 25 years before the start of waste acceptance.

The consideration of technical and institutional issues presented here has found none that would preclude the availability of a repository within this timeframe. Given DOE's revised schedule, which provides 11 years for site characterization activities instead of six, it is possible that the Yucca Mountain site could be found unsuitable after the year 2000. In this case, DOE would have fewer than 25 years to initiate site screening and develop a repository for availability by 2025. The NRC will evaluate the likelihood of this

development during the next scheduled review of the Waste Confidence Decision in 1999.

For the second part of its 1984 finding on repository availability, the Commission found reasonable assurance that sufficient repository capacity will be available within 30 years beyond expiration of any reactor OL to dispose of existing commercial high level waste and spent fuel originating in that reactor and generated up to that time. The Commission believes that this finding should also be modified in light of developments since 1984.

When the Commission made this finding, it took into consideration both technical and institutional concerns. The technical concern centered on the ability of the spent fuel and the engineered at-reactor storage facilities to meet the requirements for extended post-operational storage before shipment for disposal. The institutional question concerned whether the utility currently responsible for post-operational at-reactor storage, or some substitute organization, would be able to assure the continued safety of this storage.

The principal new developments since 1984 that bear on these questions are: (1) that dry spent fuel storage technologies have become operational on a commercial scale; and (2) that several utilities are proceeding with plans to seek renewals of their OLs, with appropriate plant upgrading, for an additional period up to 30 years beyond the 40-year term of their current licenses. The accumulation of operating experience with dry-cask storage, a technology requiring little active long-term maintenance, provides additional assurance that both the technical and institutional requirements for extended post-operational spent fuel storage will be met. License renewals, however, would have the effect of increasing requirements for both the quantity and possibly the duration of storage. If the Commission were to grant 30-year license renewals, the total operating life of some reactors could be 70 years, so that the spent fuel initially generated in such reactors would have to be stored for about 100 years, if a repository were not available until 30 years after the expiration of their last OLs. This raises the question as to whether that spent fuel, and the hardware and civil engineering structures for storing it, can continue to meet NRC requirements for an additional 30 years beyond the period the Commission supported in 1984.

For all the reasons cited in the discussion of Finding 4, the Commission believes there is ample technical basis for confidence that spent fuel can be stored safely and without significant environmental impact at these reactors for at least 100 years. If a repository were available within the first quarter of the twenty-first century, the oldest spent fuel could be shipped off the sites of all currently operating reactors well before the spent fuel initially generated in them reached the age of 100 years.

The need to consider the institutional aspects of storage beyond 30 years after OL expiration was not in evidence in 1984 because the Commission was confident that at least one repository would be available by 2007-2009. On that schedule, waste acceptance of spent fuel from the first reactor whose operating license had expired (Indian Point 1, terminated in 1980) could have begun within 30 years of expiration of that license. If a repository does not prove to be available until 2025, however, it would not be available within 30 years of the time that OLs could be considered effectively to have expired for Indian Point 1 and the three other plants with spent fuel onsite that were retired before the end of their licensed life for reactor operation. The same would be true of any additional reactors prematurely retired between now and 1995, when the 30-year clock starts for the availability of a repository by 2025. Premature shutdowns notwithstanding, the Commission has reasons to be assured that the spent fuel at all of these reactors will be stored safely and without significant environmental impact until sufficient repository capacity becomes available.

Considering first the technical reasons for this assurance, it is important to recognize that each of these reactors and its spent fuel storage installation were originally licensed in part on the strength of the applicant's showing that the systems and components of concern were designed and built to assure safe operation for 40 years under expected normal and transient severe conditions. All of the currently retired reactors have a significant portion of that 40-year expected life remaining, and all have only small quantities of spent fuel onsite in storage installations that were licensed to withstand considerably larger thermal and radiation loadings from much greater quantities of spent fuel. Of the four reactors currently retired with spent fuel onsite, the two with far the longest terms of operation, Lacrosse and Dresden, were operated for 19 and 18 years, respectively.

For the continued safe management of the spent fuel in storage installations at any existing or potential prematurely retired plant, the Commission believes it can reasonably rely on the continued structural and functional integrity of the plant's engineered storage installations for at least the balance of its originally licensed life as if the OL were still in effect. This is to say that for the purposes of Finding 2, no foreseeable technical constraints have arisen to disturb the Commission's assurance that spent fuel storage at any reactor will remain safe and environmentally acceptable for at least 30 years after its licensed life for operation, regardless of whether its OL has been terminated at an earlier date.

The Commission also sees no insurmountable institutional obstacles to the continued safe management of spent fuel during the remainder of any shutdown reactor's initially licensed life for operation, or for at least 30 years thereafter. Because there will still be an NRC possession license for the spent fuel at any reactor that has indefinitely suspended operations, the Commission will retain ample regulatory authority to require any measures, such as removal of the spent fuel remaining in storage pools to passive dry storage casks, that might appear necessary after an OL expires. Even if a licensed utility were to become insolvent, and responsibility for spent fuel management were transferred to DOE earlier than is currently planned, the Commission has no reason to believe that DOE would be unable to carry out any safety-related measures NRC considers necessary. Thus, in the case of a premature reactor retirement, the Commission has an adequate basis, on both technical and institutional grounds, for reasonable assurance that spent fuel can be stored safely and without significant environmental impacts for at least 30 years beyond not only the actual end of that reactor's OL, but the end of its originally licensed life for operation.

In sum, considering developments since 1984 in the repository development program, in the operating performance of U.S. power reactors, and in spent fuel storage technology, the Commission finds that: (1) the overall public health, safety, and environmental impacts of the possible unavailability of a repository by 2007-2009 would be insignificant; and (2) neither 30-year renewals of reactor licenses nor a delay in repository availability to 2025 will result in significant safety or environmental impacts from extended post-operational spent fuel storage.

The Commission finds ample grounds for its proposed revised findings on the expected availability of a repository. The institutional support for the repository program is well-established. A mechanism for funding repository

program activities is in place, and there is a provision in the NWPA for adjusting, if necessary, the fee paid by utilities into this fund. Congress has continued to provide support for the repository program in setting milestones, delineating responsibilities, establishing advisory bodies, and providing a mechanism for dealing with the concerns of States and affected Indian tribes.

Technical support for extended spent fuel storage has improved since 1984. Considering the growing availability, reasonable cost, and accumulated operating experience with new dry cask spent fuel storage technology since then, the Commission now has even greater assurance that spent fuel can be stored safely and without significant environmental impact for at least 30 years after the expected expiration of any reactor's OL. Where a reactor's OL has been terminated before the expected expiration date, the Commission has an adequate basis to reaffirm what was implicit in its initial concept, namely: that regardless of the actual date when the reactor's operating authority effectively ended, spent fuel can be stored safely and without significant environmental impacts for at least 30 years beyond that reactor's licensed life for operation.

There is thus no foreseeable health and safety or environmental requirement that a repository be made available within the 2007-2009 timeframe at issue in the Commission's original proceeding.

Indeed, the Commission sees important NRC mission-related grounds for avoiding any statement that repository operation by 2007-2009 is required. Geologic disposal of high-level radioactive wastes is an unprecedented endeavor. It requires reliable projections of the waste isolation performance of natural and engineered barriers over millennia. After the repository is sealed, retrieval of the emplaced wastes will no longer be practicable, and the commitment of wastes to that site will, by design, be irreversible. In DOE's testing, both in the laboratory and at the candidate repository site, in its development of facility and waste-package designs, and in all other work to demonstrate that NRC requirements will be met for a repository at Yucca Mountain, the Commission believes that the confidence of both NRC and the public depends less on meeting the schedule for repository operation than on meeting safety requirements and doing the job right the first time. Thus, given the Commission's assurance that spent fuel can safely be stored for at least 100 years if necessary, it appears prudent for all concerned to prepare for the better-understood and more manageable problems of storage for a few more years in order to provide additional time to assure the success of permanent geologic disposal.

This is not to say that the Commission is unsympathetic to the need for timely progress toward an operational repository. It is precisely because NRC is so confident of the national commitment to achieve early repository operation that the Commission believes it no longer need add its weight to the considerable pressures already bearing on the DOE program. There is ample institutional impetus on the part of others, including Congress, the nuclear power industry, State utility rate regulatory bodies, and consumers of nuclear-generated power, toward DOE achievement of scheduled program milestones. With continuing confidence in the technical feasibility of geologic disposal, the Commission has no reason to doubt the institutional commitment to achieve it in a timeframe well before it might become necessary for safety or environmental reasons. Indeed, the Commission believes it advisable not to attempt in this review a more precise NRC estimate of the point at which a repository will be needed for radiological safety or environmental reasons, lest this estimate itself undermine the commitment to earlier achievement of repository operations.

To find reasonable assurance that a repository will be available by 2007-2009, however, is a different and more consequential proposition in the context of this review. In light of the delays the program has encountered since its inception, and the regulatory need to avoid a premature commitment to the Yucca Mountain site, the Commission could not prudently describe a basis for assurance that the previous DOE schedule for repository operation in 2003 would not slip another four to six years under any reasonably foreseeable circumstances. The NRC believes it is more realistic to expect that a repository at the Yucca Mountain site could be available by the year 2010 or a few years thereafter, if the Yucca Mountain site is found to be suitable. This revised estimate, however, could too easily be misinterpreted as an NRC estimate of the time at which continued spent fuel storage at these sites would be unsafe or environmentally significant. The Commission's enhanced confidence in the safety of extended spent fuel storage provides adequate grounds for the view that NRC need not at this time define more precisely the period when, for reasons related to NRC's mission, a permanent alternative to post-operational spent fuel storage will be needed. The Commission therefore proposes the following revision of its original Finding on when sufficient repository capacity will be available:

The Commission finds reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license)[1] of any reactor to dispose of the commercial high-level radioactive waste and spent fuel originating in such reactor and generated up to that time.

Reaffirmed Finding 3: The Commission finds reasonable assurance that high-level radioactive waste and spent fuel will be managed, in a safe manner until sufficient repository capacity is available to assure the safe disposal of all high-level waste and spent fuel.

III.A. Issues Considered in Commission's 1984 Decision on Finding 3

In the Commission's discussion of Finding 3 in its Waste Confidence Decision (49 FR 34658, August 31, 1984), in Section 2.3 >Third Commission Finding,' the Commission stated,

Nuclear power plants whose operating licenses expire after the years 2007-09 will be subject to NRC regulation during the entire period between their initial operation and the availability of a waste repository. The Commission has reasonable assurance that the spent fuel generated by these licensed plants will be managed by the licensees in a safe manner. Compliance with the NRC regulations and any specific license conditions that may be imposed on the licensees will assure adequate protection of the public health and safety. Regulations primarily addressing spent fuel storage include 10 CFR Part 50 for storage at the reactor facility and 10 CFR Part 72 for storage in independent spent fuel storage installations (ISFSIs). Safety and environmental issues involving such storage are addressed in licensing reviews under both Parts 50 and 72, and continued storage operations are audited and inspected by NRC. NRC's experience in more than 80 individual evaluations of the safety of spent fuel storage shows that significant releases of radioactivity from spent fuel under licensed storage conditions are extremely remote.

Some nuclear power plant operating licenses expire before the years 2007-09. For technical, economic or other reasons, other plants may choose, or be forced to terminate operation prior to 2007-09 even though their

[1] The parenthetical phrase "which may include the term of a revised or renewed license" has been added to revised Finding 2 to make it consistent with revised Finding 4.

operating licenses have not expired. For example, the existence of a safety problem for a particular plant could prevent further operation of the plant or could require plant modifications that make continued plant operation uneconomic. The licensee, upon expiration or termination of its license, may be granted (under 10 CFR Part 50 or Part 72) a license to retain custody of the spent fuel for a specified term (until repository capacity is available and the spent fuel can be transferred to DOE under Sec. 123 of the Nuclear Waste Policy Act of 1982) subject to NRC regulations and license conditions needed to assure adequate protection of the public. Alternatively, the owner of the spent fuel, as a last resort, may apply for an interim storage contract with DOE, under Sec. 135(b) of the Act, until not later than 3 years after a repository or monitored retrievable storage facility is available for spent fuel. For the reasons discussed above, the Commission is confident that in every case the spent fuel generated by those plants will be managed safely during the period between license expiration or termination and the availability of a mined waste repository for disposal.

Even if a repository does not become available until 2025, nothing has occurred during the five years since its original Decision to diminish the Commission's confidence that high-level waste and spent fuel will be managed in a safe manner until a repository is available. The same logic just stated continues to apply through the first quarter of the twenty-first century. NRC regulations remain adequate to assure safe storage of spent fuel and radioactive high-level waste at reactors, at independent spent fuel storage installations (ISFSIs), and in an MRS until sufficient repository capacity is available.

10 CFR subsection 72.42(a) provides for renewal of licensed storage at ISFSIs for additional 20-year periods for interim storage, or for additional 40-year periods for monitored retrievable storage of spent fuel and solidified radioactive high-level waste if an MRS facility is constructed, licensed, and operated. This would ensure that spent fuel and solidified high-level waste, if any were to be delivered to an MRS facility, would remain in safe storage under NRC regulation throughout its storage. The Commission has also published for public comment a proposed amendment to part 72 to issue a general license to reactor licensees to use approved spent fuel storage casks at reactor sites. Currently, the Commission is considering the draft final amendment for this rulemaking action. If this amendment is promulgated, no specific part 72 license would be required. Operating license holders would register with NRC to use approved casks on their sites

Spent fuel may continue to be stored in the reactor spent fuel pool under a part 50 "possession only" license after the reactor has ceased operating. In addition, DOE's policy of disposing of the oldest fuel first, as set forth in its Annual Capacity Report, makes it unlikely that any significant fraction of total spent fuel generated will be stored for longer than the 30 years beyond the expiration of any operating reactor license. This expectation, established in the Commission's original proceeding, continues to be reasonable, even in the event that a repository is not available until some time during the first quarter of the twenty-first century. Even in the case of premature shutdowns, where spent fuel is most likely to remain at a site for 30 years or longer beyond OL expiration (see Finding 2, previously discussed), the Commission has confidence that spent fuel will be safely managed until safe disposal is available.

Until the reactor site has been fully decommissioned, and spent fuel has been transferred from the utility to DOE as required by NRC regulations, the licensee remains responsible to NRC. Furthermore, under 10 CFR subsection 50.54bb, originally issued in final form by the Commission with its 1984 Waste Confidence Decision, a reactor licensee must provide to NRC, five years before expiration of an OL, notice of plans for spent fuel disposition. Accordingly, the Commission concludes that nothing has changed since the enactment of the Nuclear Waste Policy Act of 1982 and the Waste Confidence Decision in August 1984 to diminish the Commission's "...reasonable assurance that high-level radioactive waste and spent fuel will be managed in a safe manner until sufficient repository capacity is available...."

Pursuant to the NWPA, the Commission issued in final form 10 CFR part 53, "Criteria and Procedures for Determining Adequacy of Available Spent Nuclear Fuel Storage Capacity," addressing the determination of need, if any, for DOE interim storage. No applications were received by the June 30, 1989 NWPA deadline incorporated into the Commission's rule, and it seems unlikely that any applications will be made to NRC for interim storage by DOE. Even if NRC had made an exception for a late application, a determination would have to have been made before January 1, 1990 to comply with the NWPA.

III.B. Relevant Issues That Have Arisen since the Commission's Original Decision on Finding 3

Although a DOE facility may not be available to enable the Department to begin accepting spent fuel in 1998, as currently provided in the contracts under the NWPA, the Commission's confidence in safe storage is unaffected by any potential contractual dispute between DOE and spent fuel generators and owners as to responsibility for spent fuel storage. In the event that DOE does not take title to spent fuel by this date, a licensee under either 10 CFR part 50 or part 72 cannot abandon spent fuel in its possession.

The Commission recognizes that the NWPA limitation of 70,000 MTHM for the first repository will not provide adequate capacity for the total amount of spent fuel projected to be generated by all currently operating licensed reactors. The NWPAA effectively places a moratorium on a second repository program until 2007-2010. Either the first repository must be authorized and able to provide expanded capacity sufficient to accommodate the spent fuel generated, or there must be more than one repository. Since Congress specifically provided in the NWPAA for a first repository, and required DOE to return for legislative authorization for a second repository, the Commission believes that Congress will continue to provide institutional support for adequate repository capacity.

The Commission's confidence about the availability of repository capacity is not affected by the possibility that some existing reactor licenses might be renewed to permit continued generation of spent fuel at these sites. Because only two reactor licenses are scheduled to expire before 2003, the impact of license renewals (a matter not considered in the Commission's 1984 Decision) will have no significant effect within the first quarter of the twenty-first century on scheduling requirements for a second repository. Renewals may slightly alleviate the need for a second repository in the short term, because spent fuel storage capacity will be expanded for extended storage at these reactor sites. Over the longer term, renewals might increase spent fuel generation well into the latter half of the twenty-first century. Nonetheless, nothing in this situation diminishes the Commission's assurance that safe storage will be made available as needed.

In summary, the Commission finds no basis for changing the Third Finding in its Waste Confidence Decision. The Commission continues to find "...reasonable assurance that high-level radioactive waste and spent fuel will be managed in a safe manner until sufficient repository capacity is

available to assure the safe disposal of all high-level waste and spent fuel."

Original Finding 4: The Commission finds reasonable assurance that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the expiration of that reactor's operating license at that reactor's spent fuel storage basin, or at either onsite or offsite independent spent fuel storage installations.

Revised Finding 4: The Commission finds reasonable assurance that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin, or at either onsite or offsite independent spent fuel storage installations.

IV.A. Issues Considered in Commission's 1984 Decision on Finding 4

In the Commission's discussion of Finding 4 in its Waste Confidence Decision (49 FR 34658; August 31, 1984) section 2.4 "Fourth Commission Finding," the Commission said that:

Although the Commission has reasonable assurance that at least one mined geologic repository will be available by the years 2007-09, the Commission also realizes that for various reasons, including insufficient capacity to immediately dispose of all existing spent fuel, spent fuel may be stored in existing or new storage facilities for some periods beyond 2007-09. The Commission believes that this extended storage will not be necessary for any period longer than 30 years beyond the term of an operating license. For this reason, the Commission has addressed on a generic basis in this decision the safety and environmental impacts of extended spent fuel storage at reactor spent fuel basins or at either onsite or offsite spent fuel storage installations. The Commission finds that spent fuel can be stored safely and without significant environmental impacts for at least 30 years beyond the expiration of reactor operating licenses. To ensure that spent fuel which remains in storage will be managed properly until transferred to DOE for disposal, the Commission is proposing an amendment to its regulations (10 CFR Part 50). The amendment will require the licensee to notify the Commission, five years prior to expiration of its reactor operating license, how the spent fuel will be managed until disposal.

The Commission's finding is based on the record of this proceeding which indicates that significant releases of radioactivity from spent fuel under licensed storage conditions are highly unlikely. It is also supported by the Commission's experience in conducting more than 80 individual safety evaluations of storage facilities.

The safety of prolonged spent fuel storage can be considered in terms of four major issues: (a) The long-term integrity of spent fuel under water pool storage conditions, (b) structure and component safety for extended facility operation, (c) the safety of dry storage, and (d) potential risks of accidents and acts of sabotage at spent fuel storage facilities.

For reasons discussed above, the Commission arrived at a provisional figure of 70 years or more for storage (i.e., a 40-year reactor OL span, plus 30 years or more).

The 70-year-plus estimate is supported by oral testimony from the nuclear industry to the Commission in the Waste Confidence Proceeding. (See Transcript of Commission Meeting, "In the Matter of: Meeting on Waste Confidence Proceeding," January 11, 1982, Washington, DC, pp. 148-160). This testimony specifically addressed safety issues related to water pool storage of spent fuel and supported the position that spent fuel could be stored for an indefinite period, citing the industry's written submittal to the Commission in the proceeding. (See "The Capability for the Safe Interim Storage of Spent Fuel" (Document 4 of 4), Utility Nuclear Waste Management Group and Edison Electric Institute, July 1980). Some of this material alluded to in the oral testimony was subsequently referenced by the Commission in its discussion of water pool storage issues and its Fourth Finding of reasonable assurance that spent fuel and high level waste "...will be managed in a safe manner." (See 49 FR 34658 at pp. 34681-2, August 31, 1984).

If a reactor with a 40-year initial license were to have that license renewed for another 30 years, the Commission believes that the spent fuel generated at that reactor can be safely stored for at least several decades past the end of the 70-year operating period. Adding to these 70 years the expected 30-year post-OL period during which the Commission believes, under Finding 2, that sufficient repository capacity will be made available for any reactor's spent fuel, the total storage time would be about 100 years.

In making the original Fourth Finding, the Commission did not determine that for technical or regulatory reasons, storage would have to be limited to 70 years. This is apparent from the Commission's use of the words "...for *at least* 30 years beyond the expiration of that reactor's operating license...[emphasis added]." Similarly, in using the words "at least" in its revised Finding Four, the Commission is not suggesting 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) represents any technical limitation for safe and environmentally benign storage. Degradation rates of spent fuel in storage, for example, are slow enough that it is hard to distinguish by degradation alone between spent fuel in storage for less than a decade and spent fuel stored for several decades.

The Commission's revised Finding here is meant to apply both to wet storage in reactor pools and dry storage in engineered facilities outside the reactor containment building. Both dry and wet storage will be discussed in detail next.

Since the original Waste Confidence Decision, which found that material degradation processes in dry storage were well-understood, and that dry-storage systems were simple, passive, and easily maintained, NRC and ISFSI operators have gained experience with dry storage which confirms the Commission's 1984 conclusions. NRC staff safety reviews of topical reports on storage-system designs, the licensing and inspection of storage at two reactor sites, and NRC promulgation of the part 72 amendment for MRS, have significantly increased the agency's understanding of and confidence in dry storage.

Under NWPA Section 218(a), DOE has carried out spent fuel storage research and development as well as demonstration of dry cask storage at its Idaho National Engineering Laboratory. Demonstration has been carried out for metal casks under review or previously reviewed by NRC staff. DOE has also provided support to utilities in dry storage licensing actions (see Godlewski, N.Z., "Spent Fuel Storage--An Update," *Nuclear News*, Vol. 30, No. 3, March 1987, pp.47-52).

Dry storage of spent fuel has become an available option for utilities, with at-reactor dry storage licensed and underway at three sites: the H. B. Robinson Steam Electric Plant, Unit 2, in South Carolina, and the Surry Nuclear Station in Virginia. A license was recently granted for a modular system at Duke Power Company's Oconee Nuclear Station site. New applications have been received in 1989 for CP&L's Brunswick site, for the Baltimore Gas and Electric Company's Calvert Cliffs site, and in 1990 for Consumer Power Company's Palisades site. Based on utility statements of intent, and projections of need for additional storage capacity at reactor sites, the NRC staff expects numerous applications from utilities over the next decade (see "Final Version Dry Cask Storage Study," DOE/RW-0220, February 1989).

Since the original Waste Confidence finding, the Commission has reexamined long-term spent fuel storage in issuing an amendment to 10 CFR part 72 to address the storage of spent fuel and high-level radioactive waste in an MRS, as envisioned by Congress in Section 141 of the NWPA. Under this rule, storage in an MRS is to be licensed for a period of 40 years, with the possibility for renewal. The Commission determined not to prepare an environmental impact statement for the proposed amendments to 10 CFR part 72, however. (See 53 FR 31651, p. 31657; August 19, 1988.) An environmental assessment and finding of no significant impact were issued because the Commission found that the consequences of long-term storage are not significant. The environmental assessment for 10 CFR part 72, "Licensing Requirements for the Independent Storage of Spent Fuel and High-Level Radioactive Waste," NUREG-1092, assessed dry storage of spent fuel for a period of 70 years after receipt of spent fuel from a reactor:

The basis chosen for evaluating license requirements for the long-term storage of spent nuclear fuel and high-level radioactive waste in an MRS is an installation having a 70-year design lifetime and a 70,000 MTU storage capability. This assessment focuses on the potential environmental consequences for a long-term storage period, a period for which the Commission needs to assure itself of the continued safe storage of spent fuel and high-level radioactive waste and the performance of materials of construction. This means the reliability of systems important to safety needs to be established to ensure that long-term storage of spent fuel and HLW does not adversely impact the environment.

For example, the staff needs to establish that systems, such as concrete shielding, have been evaluated to determine how their physical properties withstand the consequences of irradiation and heat flux for about a 70-year period. The Commission addressed structure and component safety for extended operation for storage of spent fuel in reactor water pools in the matter of waste confidence rulemaking proceeding. The Commission's preliminary conclusion is that experience with spent fuel storage provides an adequate basis for confidence in the continued safe storage of spent fuel for at least 30 years after expiration of a plant's license. The Commission is therefore confident of the safe storage of spent fuel for at least 70 years in water pools at facilities designed for a 40-year lifetime. The Commission also stated that its authority to require continued safe management of spent fuel generated by licensed plants protects the public and assures them the risks remain acceptable. In consideration of the safety of dry storage of spent fuel, the Commission's preliminary conclusions were that [its] confidence in the extended dry storage of spent fuel is based on a reasonable understanding of the material degradation processes, together with the recognition that dry storage systems are simpler and more readily maintained. In response to Nuclear Waste Policy Act of 1982 authorizations, the Commission noted; >...the Commission believes the information above [on dry spent fuel storage research and demonstration] is sufficient to reach a conclusion on the safety and environmental effects of extended dry storage. All areas of safety and environmental concern [e.g., maintenance of systems and components, prevention of material degradation, protection against accidents and sabotage) have been addressed and shown to present no more potential for adverse impact on the environmental and the public health and safety than storage of spent fuel in water pools.' At this time, the Commission is confident it can evaluate the long-term integrity of material for constructing an installation and provide the needed assurance for safe storage of spent fuel and HLW to establish the licensibility of an MRS over extended periods of time. The MRS fuel storage concepts discussed here for revision of 10 CFR Part 72 covers only dry storage concepts. [References omitted]

The Commission believes that its 1984 Fourth Finding should be changed to reflect the environmental assessment in the 10 CFR part 72 MRS rulemaking and other evidence that spent fuel can be stored, safely and without significant environmental impact, for extended periods. Although the Commission does not believe storage in excess of a century to be likely, with or without an MRS, there is the potential for storage of spent fuel for times longer than 30 years beyond the expiration of an initial, extended, or renewed reactor OL, if a reactor operating under such a license were prematurely shut down. The Commission does not, however, see any significant safety or environmental problems associated with storage for at least 30 years after the licensed life for operation of any reactor, even if this effectively means storage for at least 100 years, in the case of a reactor with a 70-year licensed life for operation.

Under the environmental assessment for the MRS rule, the Commission has found confidence in the safety and environmental insignificance of dry storage of spent fuel for 70 years following a period of 70 years of storage in spent fuel storage pools. Thus, this environmental assessment supports the proposition that spent fuel may be stored safely and without significant environmental impact for a period of up to 140 years if storage in spent fuel pools occurs first and the period of dry storage does not exceed 70 years.

The Commission has also found that experience with water-pool storage of spent fuel continues to confirm that pool storage is a benign environment for spent fuel that does not lead to significant degradation of spent fuel integrity. Since 1984, utilities have continued to provide safe additional reactor pool storage capacity through reracking, with over 110 such actions now completed. The safety of storage in pools is widely recognized among cognizant professionals. Specifically, the Commission notes one expert's view that:

During the last 40 years there has been very positive experience with the handling and storing of irradiated fuel in water; thus wet storage is now considered a proved technology. There is a substantial technical basis for allowing spent fuel to remain in wet storage for several decades. For the past two decades, irradiated Zircaloy-clad fuel has been handled and stored in water. There continues to be no evidence that Zircaloy-clad fuel degrades significantly during wet storage—this includes: fuel with burnups as high as 41,000 MWd/MTU; continuous storage of low-burnup fuel for as long as 25 years; and irradiation of fuel in reactors for periods up to 22 years. Cladding defects have had little impact during wet storage, even if the fuel is uncanned. [References omitted.] (See Bailey, W.J. and Johnston, Jr. A.B., *et al.*, "Surveillance of LWR Spent Fuel in Wet Storage," NP-3765, Electric Power Research Institute (EPRI), October 1984, pp. 2-10.)

This last conclusion has been reaffirmed by the same authors, who recently wrote: "There continues to be no evidence that LWR spent fuel with Zircaloy or stainless steel cladding degrades significantly during wet storage [EPRI 1986; International Atomic Energy Agency (IAEA) 1982]." (See "Results of Studies on the Behavior of Spent Fuel in Storage," Journal of the Institute of Nuclear Materials Management, Vol. XVI, No. 3, April 1988, p. 27.IV A).

In addition to the confidence that the spent fuel assemblies themselves will not degrade significantly in wet storage, there is confidence that the water pools in which the assemblies are stored will remain safe for extended periods:

As noted in the recent IAEA world survey, the 40 years of positive experience with wet storage illustrates that it is a fully-developed technology with no associated major technological problems. Spent fuel storage pools are operated without substantial risk to the public or the plant personnel. There is substantial technical basis for allowing spent fuel to remain in wet storage for several decades. Minor, but repairable, problems have occurred with spent fuel storage pool components such as liners, racks, and piping. [See Bailey, W.J., and Johnson, Jr., A.B., *et al.*, "Surveillance of LWR Spent Fuel in Wet Storage," EPRI NP-3765, prepared by Battelle Pacific Northwest Laboratories, Final Report, October 1984, p. 6-1.]

The studies just cited also support the view that rates of uniform corrosion of spent fuel cladding in storage pools are low over time. Localized corrosion on

cladding surfaces has also been gradual and can be expected to remain so. Cladding that has undergone damage while in the reactor core has not resulted in significant releases of radioactivity when stored in pools. Furthermore, the operational experience accumulated since the 1984 Waste Confidence Decision and NRC experience in licensing and inspection reinforce the conclusions in that Decision that wet storage involves a relatively benign environment. There are no driving mechanisms, such as temperature and pressure, to degrade storage structures or components or the fuel itself, or to spread contamination. Degradation mechanisms are gradual and well understood; they allow ample time for remedial action, including repair or replacement of any failing systems. This extensive experience adequately supports predictions of long-term integrity of storage basins.

The Commission also notes the endorsement of this basic confidence by cognizant professional organizations:

The American Nuclear Society issued a policy statement [ANS 1986] in 1986 regarding storage of spent nuclear fuel. The statement indicates that continued wet storage of spent fuel at nuclear power plant sites until the federal government accepts it under existing contracts with the utilities is safe, economical and environmentally acceptable. [See Gilbert, E.R., Bailey, W.J., and Johnson, A.B., "Results of Studies on the Behavior of Spent Fuel in Storage," Journal of the Institute of Nuclear Materials Management, Vol. XVI, No. 3, April 1988, p. 27.IV A).]

The Commission is aware that in December 1986 at the Hatch nuclear power plant, radioactive water leaked out of a spent fuel transfer canal between spent fuel pools. Contaminated water drained into a swamp and from there into the Altamaha River. Also, more recently, on August 16, 1988, a spent fuel pool cooling pump failed at the Turkey Point nuclear power plant, causing about 3000 gallons of radioactive water to leak into the spent fuel pool heat exchanger room. Approximately 1500 gallons leaked from that room to adjacent areas. Approximately six to seven gallons entered the plant intake canal via storm drains. There was no radiation release offsite in this event. However, the shoes and clothing of approximately 15 workers were contaminated.

The occurrence of operational events like these have been addressed by the NRC staff at the plants listed. The staff has taken inspection and enforcement actions to reduce the potential for such operational occurrences in the future.

The NRC staff has spent several years studying in detail catastrophic loss of reactor spent fuel pool water possibly resulting in a fuel fire in a dry pool, and recently participated in litigation over this issue relative to Vermont Yankee. The 1987 report, "Severe Accidents in Spent Fuel Pools in Support of Generic Safety Issue 82" (NUREG/CR-4982), referred to in Public Citizen's comment represents an early part of the NRC's study. Subsequent study of the consequences and risks due to a loss of coolant water from spent fuel pools was conducted by the NRC, and the results were published in NUREG/CR-5176, "Seismic Failure and Cask Drop Analysis of the Spent Fuel Pools at Two Representative Nuclear Power Plants," January 1989, and NUREG-1353, "Regulatory Analysis for the Resolution of Generic Issue 82, >Beyond Design Basis Accidents in Spent Fuel Pools'," April 1989. These reports were cited in the Commission's Proposed Waste Confidence Decision Review (54 FR 39767-39797, at p.39795, September 28, 1989). Also issued in 1989, as part of the NRC staff's study, was "Value/Impact Analyses of Accident Preventive and Mitigative Options for Spent Fuel Pools" (NUREG/CR-5281).

The primary concern regarding accidents in spent fuel pools is the loss of water and its capability to cool the radioactive fuel. Without sufficient water cooling, some performance assessment models suggest that the fuel's zircaloy cladding may initiate and sustain rapid oxidation (fire) that may spread to adjacent fuel assemblies, with the potential of releasing large amounts of radioactivity.

The analyses reported in these NUREGs indicate that the dominant accident sequence which contributes to risk in a spent fuel pool is gross structural failure of the pool due to seismic events. Risks due to other accident scenarios (such as pneumatic seal failures, inadvertent drainage, loss of cooling or make-up water, and structural failures due to missiles, aircraft crashes and heavy load drops) are at least an order of magnitude smaller. For this study, older nuclear power plants were selected, since the older plants are more vulnerable to seismic-induced failures. The selected plants included the Vermont Yankee and the H.B. Robinson plants.

Although these studies conclude that most of the spent fuel pool risk is derived from beyond design basis earthquakes, this risk is no greater than the risk from core damage accidents due to seismic events beyond the safe-shutdown earthquake. Because of the large inherent safety margins in the design and construction of the spent fuel pool analyzed, it was determined that no action was justified to further reduce the risk (NUREG-1353). As stated in the Preface to NUREG-1353:

This report presents the regulatory analysis, including decision rationale, for the resolution of Generic Issue 82, >Beyond Design Basis Accidents in Spent Fuel Pools.' The object of this regulatory analysis is to determine whether the use of high density storage racks for the storage of spent fuel poses an unacceptable risk to the health and safety of the public. As part of this effort, the seismic hazards for two older spent fuel pools were evaluated. The risk change estimates, value/impact and cost-benefit analyses, and other insights gained during this effort, have shown that no new regulatory requirements are warranted in relation to this generic issue.

Thus, supported by the consistency of NRC experience with that of others, the Commission has concluded that spent fuel can be stored safely and without significant environmental impact, in either wet storage or in wet storage followed by dry storage, for at least 100 years. The Commission considers it unlikely, however, that any fuel will actually remain in wet storage for 100 years or even for 70 years. We anticipate that, consistent with the currently developing trend, utilities will move fuel rods out of spent fuel pools and into dry storage to make room in pools for freshly-discharged spent fuel.

Although the Commission has concluded that reactor spent fuel pools can safely be used to store spent fuel for 100 years, there is no technically compelling reason to use them that long. If reactor licenses are renewed for as long as 30 years, making a total of 70 years of operation, it will be necessary to store the spent fuel discharged at the end of the reactor's operation in a spent fuel pool for several years to allow for radioactive decay and thermal cooling. After this period, the fuel could be placed in dry storage and the spent fuel pool decommissioned. Thus, for most reactors, the most likely maximum period of storage will be well within the extended 30-year post-operational period under the Commission's proposed revision to Finding 4. Moreover, considering that under certain conditions spent fuel can be stored safely and without significant environmental impacts for up to 140 years, the Commission believes there is ample basis for confidence in storage for at least 100 years.

In its 1984 Waste Confidence Decision, the Commission also concluded that "there are no significant additional non-radiological impacts which could adversely affect the environment if spent fuel is stored beyond the expiration of operating

licenses for reactors" (see 49 FR 34658 at p. 34686, August 31, 1984). The Commission did not find anything to contradict this conclusion in its 1988 rulemaking amending 10 CFR part 72 for long-term spent fuel and high-level waste storage at an MRS:

In August 1984, the NRC published an environmental assessment for this proposed revision of Part 72 NUREG-1092, >Environmental Assessment for 10 CFR Part 72, Licensing Requirements for the Independent Storage of Spent Fuel and High-Level Radioactive Waste.' NUREG-1092 discusses the major issues of the rule and the potential impact on the environment. The findings of the environmental assessment are >(1) past experience with water pool storage of spent fuel establishes the technology for long-term storage of spent fuel without affecting the health and safety of the public. (2) the proposed rulemaking to include the criteria of 10 CFR Part 72 for storing spent nuclear fuel and high-level radioactive waste does not significantly affect the environment. (3) solid high-level waste is comparable to spent fuel in its heat generation and in its radioactive material content on a per metric ton basis, and (4) knowledge of material degradation mechanisms under dry storage conditions and the ability to institute repairs in a reasonable manner without endangering the health [and safety] of the public shows dry storage technology options do not significantly impact the environment.' The assessment concludes that, among other things, there are no significant environmental impacts as a result of promulgation of these revisions of 10 CFR Part 72.

Based on the above assessment, the Commission concludes that the rulemaking action will not have a significant incremental environmental impact on the quality of the human environment. [53 FR 31651 at pp. 31657-31658; August 19, 1988.]

Thus, the 1988 amendments to 10 CFR part 72 provide the basis for the Commission to conclude that the environmental consequences of long-term spent fuel storage, including non-radiological impacts, are not significant.

Finally, no considerations have arisen to affect the Commission's confidence since 1984 that the possibility of a major accident or sabotage with offsite radiological impacts at a spent-fuel storage facility is extremely remote. NRC has recently reexamined reactor pool storage safety in two studies, "Seismic Failure and Cask Drop Analyses of the Spent Fuel Pools at Two Representative Nuclear Power Plants" (NUREG/CR-5176) and "Beyond Design Basis Accidents in Spent Fuel Pools" (NUREG-1353). These studies reaffirmed that there are no safety considerations that justify changes in regulatory requirements for pool storage. Both wet- and dry-storage activities have continued to be licensed by the Commission. In its recent rulemaking amending 10 CFR part 72 to establish licensing requirements for an MRS, the Commission did choose to eliminate an exemption regarding tornado missile impact "...to assure designs continue to address maintaining confinement of particulate material." (53 FR 31651, p. 31655, August 19, 1988). However, NRC staff had previously considered tornado missile impacts in safety reviews of design topical reports and in licensing reviews under 10 CFR part 72.

IV.B. Relevant Issues That Have Arisen since the Commission's Original Decision on Finding 4

In its original Finding 4, the Commission found reasonable assurance of safe storage without significant environmental impacts for at least 30 years beyond reactor OL expiration. Delays and uncertainties in the schedule for repository availability since the 1984 Decision have convinced the Commission to allow some margin beyond the scheduled date for repository opening currently cited by DOE. As noted in Finding 2, the Commission has reasonable assurance that at least one repository will be available within the first quarter of the twenty-first century. For all currently operating reactors, this would still be within the period of 30 years from expiration of their OLs, which the Commission previously found to be the minimum period for which spent fuel storage could be considered safe and without significant environmental impact.

Under the NWPA as amended, DOE is authorized to dispose of up to 70,000 MTHM in the first repository before granting a construction authorization for a second. Under existing licenses, projected spent fuel generation could exceed 70,000 MTHM as early as the year 2010. Possible extensions or renewals of OLs also need to be considered in assessing the need for and scheduling the second repository. It now appears that unless Congress lifts the capacity limit on the first repository--and unless this repository has the physical capacity to dispose of all spent fuel generated under both the original and extended or renewed licenses--it will be necessary to have at least one additional repository. Assuming here that the first repository is available by 2025 and has a capacity on the order of 70,000 MTHM, additional disposal capacity would probably not be needed before about the year 2040 to avoid storing spent fuel at a reactor for more than 30 years after expiration of reactor OLs.

Although action on a second repository before the year 2007 would require Congressional approval, the Commission believes that Congress will take the necessary action if it becomes clear that the first repository site will not have the capacity likely to be needed. If DOE were able to address the need for a second repository earlier, for example by initiating a survey for a second repository site by the year 2000, DOE might be able to reduce the potential requirement for extended spent fuel storage in the twenty-first century. The Commission does not, however, find such action necessary to conclude that spent fuel can be stored safely and without significant environmental impact for extended periods.

The potential for generation and onsite storage of a greater amount of spent fuel as a result of the renewal of existing OLs does not affect the Commission's findings on environmental impacts. In Finding 4, the Commission did not base its determination on a specific number of reactors and amount of spent fuel generated. Rather, the Commission took note of the safety of spent fuel storage and lack of environmental impacts overall, noting that individual actions involving such storage would be reviewed. In the event there were applications for renewal of existing reactor OLs, each of these actions would be subject to safety and environmental reviews, with subsequent issuance of an environmental assessment or environmental impact statement, which would cover storage of spent fuel at each reactor site during the period of the renewed license.

The Commission also notes that the amount of spent fuel expected to be discharged by reactors has continued to decline significantly, a trend already noted in the Commission's discussion of its Finding 5 (49 FR 34658 at p. 34687, August 31, 1984). At the time of the Commission's decision, "...the cumulative amount of spent fuel to be disposed of in the year 2000 [was] expected to be 58,000 metric tons of uranium" (see "Spent Fuel Storage Requirements" (Update of DOE/RL-82-17) DOE/RL-83-1, January, 1983). Today, that figure has declined to 40,200 metric tons, the lower reference case which represents the conservative upper bound of commercial nuclear power growth (see "Integrated Data Base for 1989: Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics," DOE/RW-0006, Rev. 5, November 1989). The amount of spent fuel considered likely to be discharged by the year 2000 in the Commission's 1984 decision will not be attained until the end of calendar year 2010, if then.

The Commission believes that its 1984 Finding 4 should be revised to acknowledge the possibility and assess the safety and environmental impacts of extended storage for periods longer than 70 years. The principal reasons for this proposed revision are that: (1) the long-term material and system degradation effects are well understood and known to be minor; (2) the ability to maintain the system is assured; and (3) the Commission maintains regulatory authority over any spent fuel storage installation.

On the basis of experience with wet and dry spent fuel storage and related rulemaking and licensing actions, the Commission concludes that spent fuel can be safely stored without significant environmental impact for at least 100 years, if necessary. Therefore, the Commission is revising its original Fourth Finding thus: "The Commission finds reasonable assurance that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin, or at either onsite or offsite independent spent fuel storage installations."

Reaffirmed Finding 5: The Commission finds reasonable assurance that safe independent onsite spent fuel storage or offsite spent fuel storage will be made available if such storage capacity is needed.

V.A. Issues Considered in Commission's 1984 Decision on Finding 5

In its discussion of Finding 5 of its Waste Confidence Decision (49 FR 34658; August 31, 1984), the Commission said that:

The technology for independent spent fuel storage installations, as discussed under the fourth Commission Finding, is available and demonstrated. The regulations and licensing procedures are in place. Such installations can be constructed and licensed within a five-year time interval. Before passage of the Nuclear Waste Policy Act of 1982 the Commission was concerned about who, if anyone, would take responsibility for providing such installations on a timely basis. While the industry was hoping for a government commitment, the Administration had discontinued efforts to provide those storage facilities.... The Nuclear Waste Policy Act of 1982 establishes a national policy for providing storage facilities and thus helps to resolve this issue and assure that storage capacity will be available.

Prior to March 1981, the DOE was pursuing a program to provide temporary storage in off-site, or away-from-reactor (AFR), storage installations. The intent of the program was to provide flexibility in the national waste disposal program and an alternative for those utilities unable to expand their own storage capacities.

Consequently, the participants in this proceeding assumed that, prior to the availability of a repository, the Federal government would provide for storage of spent fuel in excess of that which could be stored at reactor sites. Thus, it is not surprising that the record of this proceeding prior to the DOE policy change did not indicate any direct commitment by the utilities to provide AFR storage. On March 27, 1981, DOE placed in the record a letter to the Commission stating its decision >to discontinue its efforts to provide Federal government-owned or controlled away-from-reactor storage facilities.' The primary reasons for the change in policy were cited as new and lower projections of storage requirements and lack of Congressional authority to fully implement the original policy.

The record of this proceeding indicates a general commitment on the part of industry to do whatever is necessary to avoid shutting down reactors or derating them because of filled spent fuel storage pools. While industry's incentive for keeping a reactor in operation no longer applies after expiration of its operating license, utilities possessing spent fuel are required to be licensed and to maintain the fuel in safe storage until removed from the site. Industry's response to the change in DOE's policy on federally-sponsored away-from-reactor (AFR) storage was basically a commitment to do what is required of it, with a plea for a clear unequivocal Federal policy.... The Nuclear Waste Policy Act of 1982 has now provided that policy.

The Nuclear Waste Policy Act defines public and private responsibilities for spent fuel storage and provides for a limited amount of federally-supported interim storage capacity. The Act also includes provisions for monitored retrievable storage facilities and for a research development and demonstration program for dry storage. The Commission believes that these provisions provide added assurance that safe independent onsite or offsite spent fuel storage will be available if needed. [References omitted]

The policy set forth in the NWPA regarding interim storage remains in place. Therefore, the Commission's confidence remains unchanged. The only policy change affecting storage involves long-term storage in an MRS. The NWPAA sets schedule restrictions on an MRS by tying it to the repository siting and licensing schedule. These restrictions effectively delay implementation of an MRS. Consequently, its usefulness in providing storage capacity relief to utilities is likely to be lost.

The NWPAA established a Monitored Retrievable Storage Review Commission tasked with preparing a report on the need for an MRS facility as part of the national nuclear waste management system (section 143(a)). In its November 1989 report "Nuclear Waste: Is There a Need for Federal Interim Storage?", the MRS Commission reached the following conclusion:

An MRS linked as provided in current law would not be justified, especially in light of uncertainties in the completion time for the repository. Consequently, the Commission does not recommend a linked MRS as required by current law and as proposed by DOE.

In the November 1989 Reassessment Report, DOE stated that

current linkages between the repository and MRS program make it impossible for the DOE to accept waste at an MRS facility on a schedule that is independent from that of the repository. Therefore, the DOE plans to work with the Congress to modify the current linkages between the repository and the MRS facility and to embark on an aggressive program to develop an integrated MRS facility for spent fuel. The DOE believes that if the linkages are modified, it is likely that waste acceptance at an MRS facility could begin by 1998 or soon thereafter.

Although the Commission's confidence in its 1984 Decision did not depend on the availability of an MRS facility, the possibility of such a facility, as provided for in the NWPA, was one way in which needed storage could be made available. The NWPAA makes an MRS facility less likely by linking it to repository development, unless Congress is willing to modify these linkages. The potential impact of the uncertainty surrounding an MRS on the Commission's confidence is, however, more than compensated for by operational and planned spent fuel pool expansions and dry-storage investments by utilities themselves--developments that had not been made operational at the time of the original Waste Confidence Decision. Consequently, the current statutory restrictions that may make an MRS ineffective for timely storage capacity relief are of no consequence for the Commission's finding of confidence that adequate storage capacity will be made available if needed.

Although the NWPAA limits the usefulness of an MRS by linking its availability to repository development, the Act does provide authorization for an MRS facility. The Commission has remained neutral since its 1984 Waste Confidence Decision with respect to the need for authorization of an MRS facility. The Commission does not consider the MRS essential to protect public health and safety. If any offsite storage capacity is required, utilities may make application for a license to store spent fuel at a new site. Consequently, while the NWPAA provision does affect MRS development and therefore can be said to be limiting,

the Commission believes this should not affect its confidence in the availability of safe storage capacity.

V.B. Relevant Issues That Have Arisen since the Commission's Original Decision on Finding 5

DOE will probably not be able to begin operation of a repository before 2010 under current plans, and operation might begin somewhat later. Given progress to date on an MRS, the link between MRS facility construction and repository construction authorization established by the NWPAA, and the absence of other concrete DOE plans to store the spent fuel, it seems unlikely that DOE will meet the 1998 deadline for taking title to spent fuel, unless DOE is successful in its efforts to work with Congress to modify the linkages. (Under section 302(a)(5)(B) of the NWPA, "...the Secretary, beginning not later than January 31, 1998, will dispose of the high-level radioactive waste or spent nuclear fuel [subject to disposal contracts].") This potential problem does not, however, affect the Commission's confidence that storage capacity will be made available as needed.

The possibility of a dispute between DOE and utilities over the responsibility for providing spent fuel storage will not affect the public health and safety or the environment. Uncertainty as to contractual responsibilities raises questions concerning: (1) who will be responsible; (2) at what point in time responsibility for the spent fuel will be transferred; (3) how the fuel will be managed; (4) how the transfer of management responsibility from the utilities to DOE will take place; and (5) how the cost of DOE storage might differ, if at all, from utility storage. Utilities possessing spent fuel in storage under NRC licenses cannot abrogate their safety responsibilities, however. Until DOE can safely accept spent fuel, utilities or some other licensed entity will remain responsible for it.

Estimates of the amount of spent fuel generated have continued to decline. At the time of the Commission's Decision, the Commission cited in Finding 5 the cumulative figure of 58,000 metric tons uranium of spent fuel generated in the year 2000 (See 49 FR 34658, p. 34697, August 31, 1984.) More recently, DOE estimated 40,200 metric tons the lower reference case which represents the conservative upper bound of commercial nuclear power growth (see "Integrated Data Base for 1989: Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics," DOE/RW-0006, Rev. 5, November 1989). Although estimates may show an increase at some date well into the twenty-first century if licenses of some reactors are renewed or extended, this possibility does not affect the Commission's confidence in the availability of safe storage capacity until a repository is operational. The industry has made a general commitment to provide storage capacity, which could include away-from-reactor (AFR) storage capacity. To date, however, utilities have sought to meet storage capacity needs at their respective reactor sites. Thus, a new industry application for AFR storage remains only a potential option, which currently seems unnecessary and unlikely.

Utilities have continued to add storage capacity by reracking spent fuel pools, and NRC expects continued reracking where it is physically possible and represents the least costly alternative. Advances in dry-storage technologies and utility plans both have a positive effect on NRC's confidence. At the time the Commission reached its original findings, dry storage of LWR spent fuel was, as yet, unlicensed under 10 CFR part 72, and DOE's dry-storage demonstrations in support of dry-cask storage were in progress at the Idaho National Engineering Laboratory (INEL).

Today, DOE's demonstration efforts have been successful (See Godlewski, N. Z., "Spent Fuel Storage-An Update," *Nuclear News*, Vol. 30, No. 3, March 1987, pp. 47-52, at p. 47.) Dry storage has been licensed at three reactor sites, and three new applications are under review. Dry cask storage is licensed at Virginia Electric Power Company's Surry Power Station site (see License, SNM 2501 under Docket No. 72-2), and dry-concrete module and stainless-steel canister storage is licensed at Carolina Power and Light Company's (CP&L's) H. B. Robinson, Unit 2, site (see License SNM 2502, under Docket No. 72-3). A license was recently granted for a similar modular system at Duke Power Company's Oconee Nuclear Station site. New applications have been received in 1989 for CP&L's Brunswick site, the Baltimore Gas and Electric Company's Calvert Cliffs site, and in 1990 for Consumer Power Company's Palisades site. Applications are also expected for CP&L's Robinson 2 site (at another onsite location to allow for greater storage capacity) and Wisconsin Electric Power Company's Point Beach site. The Tennessee Valley Authority has indicated that it will apply for a licensed dry storage installation at its Sequoyah plant site.

Thus, the successful demonstration by DOE of dry cask technology for various cask types at INEL, utilities' actions to forestall spent fuel storage capacity shortfalls, and the continuing sufficiency of the licensing record for the Commission to authorize increases in at-reactor storage capacity all strengthen the Commission's confidence in the availability of safe and environmentally sound spent fuel storage capacity.

Renewal of reactor OLs will involve consideration of how additional spent fuel generated during the extended term of the license will be stored onsite or offsite. There will be sufficient time for construction and licensing of any additional storage capacity needed.

In summary, the Commission finds no basis to change the Fifth Finding in its Waste Confidence Decision. Changes by the NWPAA, which may lessen the likelihood of an MRS facility, and the potential for some slippage in repository availability to the first quarter of the twenty-first century (see our discussion of Finding 2) are more than offset by the continued success of utilities in providing safe at-reactor-site storage capacity in reactor pools and their progress in providing independent onsite storage. Therefore, the Commission continues to find "...reasonable assurance that safe independent onsite spent fuel storage or offsite spent fuel storage will be made available if such storage is needed."

Dated at Rockville, Maryland, this 11th day of September 1990.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,

Secretary of the Commission.

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